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DEPARTMENT OF AGRICULTURE.
BOTANICAL DIVISION.
BULLETIN NO. 5.

SECTION OF VEGETABLE PATHOLOGY.

REPORT

ON THE

EXPERIMENTS MADE IN 1887 IN THE TREATMENT OF THE DOWNY MILDEW AND THE BLACK-ROT

OF THE

GRAPE VINE,

WITH A CHAPTER ON THE APPARATUS FOR APPLYING
REMEDIES FOR THESE DISEASES.

PREPARED BY F. LAMSON SCRIBNER,
UNDER THE DIRECTION OF THE COMMISSIONER OF AGRICULTURE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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LETTER OF SUBMITTAL.

SIR: I have the honor to submit to you the accompanying report on the treatments of the downy mildew and black-rot, made under the direction of, or in accordance with, instructions issued by this Department during the summer of 1887. To this is supplemented a report on the results of similar experiments made in France, together with a chapter on apparatus for combating the mildew, the latter communicated by Prof. P. Ferrrouillat, Rural Engineer at the National School of Agriculture, Montpellier, France.

The wide area over which these experiments have been made and the different climatic conditions under which they have been conducted adds greatly to their value, yet the results can in no way be deemed conclusive. This is especially evident in the diverse results obtained by parties who have apparently pursued the same line of experiments. The manifestly good results obtained by the employment of the remedies tried for mildew and, in some cases also, for black-rot shows the importance of continuing the work until their actual value is fully demonstrated. What has been accomplished as detailed in this report, is decidedly encouraging, and with the experience thus gained we may reasonably hope for better and more decisive results the coming season.

Respectfully,

F. LAMSON SCRIBNER,
Chief of Section of Vegetable Pathology.

HON. NORMAN J. COLMAN,
Commissioner of Agriculture.

PART I.

REPORTS OF SPECIAL AGENTS ON THE TREATMENT OF THE DOWNY MILDEW AND BLACK-ROT OF THE VINE WITH THE SALTS OF COPPER IN 1887.

EXPERIMENTS AT CHARLOTTESVILLE, VA.

SIR: I have the honor to submit the following report of experiments in the treatment of the downy mildew and black-rot of the grape-vine, made in accordance with your letters of instruction dated May 31 and June 8, respectively, and the request contained in your circular of May, 1887.

The kind of remedies employed.—Six different remedies were employed, namely: Copper mixture of Gironde (or Bordeaux mixture); blue water or eau celeste; simple solutions of sulphate of copper (1 pound to 22 gallons, and 2 pounds to 22 gallons); sulphatine and David's powder.

The ingredients and formulæ.—These were furnished by your Department and were prepared by me in accordance with instructions received therewith, the repetition of which is perhaps advisable in this connection.

(1) Prepare what is known as the copper mixture of Gironde, or Bordeaux mixture, by dissolving in a wooden vessel 8 pounds of sulphate of copper in 15 gallons of water (the solution of the copper salt will be more quickly effected by using warm or hot water).

In another vessel slake 10 pounds of lime in 5 gallons of water. When both the copper solution and the lime mixture are cooled to the ordinary temperature of the air pour the latter slowly into the former, taking care to mix the fluids thoroughly by constant stirring during the operation.

When ready to apply this compound to the vines, again stir it thoroughly, pour a sufficient quantity into the copper reservoir of the pump, attach to the spraying nozzle the cap with the larger aperture, and proceed to make the application. The application should be made late in the afternoon or during cloudy weather. If it be made in dry weather, and a continuance of dry weather follows the application, spray the foliage with clear water, using the nozzle-cap of fine aperture.* This will insure a uniform distribution of the copper compound over the surface of the leaves. The amount of material as above prescribed is probably sufficient to cover one-half an acre of vines. Spray the foliage well and let the amount cover what it will—a half acre, more or less. In the treated area leave one to several rows untreated to serve as control experiments.

(2) Prepare "blue water," or eau celeste, by dissolving 1 pound of sulphate of copper in 3 or 4 gallons of hot water. When the copper salt has completely dissolved and the solution cooled, add 1 pint of liquid commercial ammonia. When ready to apply this remedy, dilute to 22 gallons and proceed as in the case of

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* The nozzle used was the Vermorel, a modification of the eddy chamber or cyclone nozzle.

the copper mixture of Gironde, using the nozzle-cap of finer aperture. Should the strength here prescribed prove harmful to the foliage of the vines, which should be determined before making the general application, reduce it by adding more water.

(3) Prepare a simple solution of sulphate of copper by dissolving 1 pound of this salt in 22 gallons of water. Apply in the same manner as eau celeste, observing the same precautions.

(4) Prepare a second simple solution of sulphate of copper at the rate of 2 pounds to 22 gallons of water. Apply with pump and fine sprayer. Test the effect of this on a few vines before making the general application.

(5) Sulphatine. This compound is sent you ready for use. Apply with the Woodason double-cone bellows, by preference when there is dew upon the foliage or when it is damp with moisture. Use 10 pounds of this material at the first application, 12 pounds the second, and 14 the third, covering the same area each time.

(6) Prepare David's powder by dissolving 4 pounds of sulphate of copper in as little water as possible; in another vessel slake 15 pounds of lime in the least amount of water necessary for this purpose, then mix these two preparations thoroughly, let the compound dry, after which it is to be crushed and sifted. Apply with the bellows as in the case of sulphatine.

Dates of applications, cost of preparing and applying the remedies, etc.

Preparation used.	When applied.			No. of vines treated.	Cost of material.	Cost of preparation.	Cost of application.	Total cost.	Cost per vine.
	June.	June.	July.						
Bordeaux mixture	1	22	9	143	\$1.86	\$0.30	\$0.48	\$2.64	\$0.018
Eau celeste	2	22	11	142	$.49\frac{1}{2}$	.15	$.30\frac{7}{9}$	.94	.006
Sulphatine	1	21	9	142	1.98	....	$.47\frac{1}{3}$	$2.45\frac{2}{3}$	.017
David's powder	2	22	11	203	1.24	$.60\frac{1}{3}$	$1.27\frac{2}{3}$	3.12	.015
Simple solution No. 1	3	23	12	175	$.19\frac{1}{2}$	.15	$.34\frac{4}{9}$	.68	.003
Simple solution No. 2	3	23	12	208	.49	.15	$.38\frac{1}{9}$	$1.02\frac{1}{4}$	.004

VARIETY OF VINES TREATED.

With the Bordeaux mixture.—Rogers' hybrids, Rickett's and Grein's seedlings, Concord, Moore's Early, Cottage, Worden, Delaware, Lady, Pocklington, Jefferson, Montgomery, Ives, Hartford, Wyoming, Red, Vergennes, Duchess, Prentiss, Martha.

With eau celeste.—Catawba, Elvira, Bacchus, Goethe, Delaware, Lindley, Lady Washington, Salem, Martha.

With sulphatine.—Wilding, Etta, Grein's Golden, Missouri Reisling, Uhland, Empire State, Lutie, Triumph, Marion, Rebecca, Montifiore.

With David's powder.—Champion.

With simple solution No. 1.—Cottage, Lindley, Black Eagle, Norton.

With simple solution No. 2.—Norton's Virginia.

In each plat a number of vines were left untreated to serve as control experiments.

The lesser cost of applying eau celeste, simple solutions, Nos. 1 and 2, is owing to the use of a nozzle with fine aperture, by which both time and material were economized.

The lesser cost of making the second and third applications of Bordeaux mixture was owing to a very good proportion of the the first application still showing upon the foliage.

Two elements enter into the cost of applying both of the powder preparations, namely, the spraying of water as a forerunner of the ap plication, and the application itself; and I was forced to incur this expense owing to the absence of dew, which at best never presents a uniform spread of moisture upon the entire foliage.

The items of cost are based upon competent labor at 10 cents per hour, supervision not being allowed for.

Mildew was first seen May 31 although it perhaps existed a day or two before; it, however, prevailed but little before the 6th of June and was not so generally prevalent as to affect all varieties, including Norton's Virginia, until the 20th of June, when it was also to be seen on the new shoots of the vines previously-treated.

Black-rot was first seen June 4 and increased quite rapidly during the 6th, 7th, and 8th, but did not begin to show on Norton's Virginia until June 21 and 22, at which time fresh rot appeared on the Concord, Catawba, Delaware, and others. On the 8th and 9th of July a third visitation of more or less virulence was plainly observed.

In 1885 the vineyard was comparatively free from mildew and black-rot, a fact which was then attributed to the youthfulness of the vines, but which I regarded to have been wholly due to careful and generous culture. In 1886 mildew and black-rot were present and did material harm to all the tender varieties, and showed a strong influence on what had previously been regarded as resistant varieties, prominent in which class was the Norton's Virginia. The same careful and generous culture had been continued, but the crop showed much less favorable results than in 1885.

The condition of the vines with respect to disease at the time of the first application was good, both as to the vigor of the foliage and florescence, nor was there at that time any appearance of disease.

At the time of the second application, the foliage already treated with Bordeaux mixture was free from mildew, but the shoots of the growth subsequent to the first treatment gave warning of mildew, and black-rot had already materially damaged the Concord, Catawba, Delaware, and all the Vinifera hybrids, and had begun its work upon Grein's and Rommel's seedlings and Norton's Virginia.*

The foliage already treated with first simple solution of sulphate of copper was slightly scorched. The second solution had killed some of the younger leaves, and the canes of tender varieties. It is proper to state here that the vines treated with each of the two latter solutions were three years old Norton's Virginia.

The vines left untreated, forming control experiments, clearly showed the absence of any influence which might tend to check the ravages of mildew and black rot.

The condition of the vines at the third application with respect to mildew was generally good where previously treated, excepting the plats where the first and second simple solutions were used, while the untreated portions, especially in the case of those varieties which are known to be particularly subject to mildew, clearly showed that the treatment was essential to their preservation, and that a continued omission of preventive measures would necessarily result in their extermination. In respect to black-rot one could not see that any of the treatments above referred to, in any degree checked its ravages.

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* The foliage of Elvira in the plat already treated with eau celeste was scorched to a somewhat injurious extent.

Condition of weather when the applications of remedies were made, and the kind of weather immediately following.—For two days preceding the first application, humidity had increased to 80.6 and 83, the weather was cloudy and rainy, and 1.88 inches of rain had fallen. This condition continued for the three days of the application, during which time the temperature increased, southeast winds prevailed, and 1.57 inches of rain fell. For three days immediately following the first application humidity diminished and rain-fall ceased, which was again followed by high humidity and temperature and rain-fall of 1.27 inches in three days. After this clear, dry weather prevailed until June 20, the time of the second application. This was begun with humidity 75, mean temperature 79, southeast wind, and weather clear to hazy, and in the two succeeding days of treatment humidity went to 99, wind was south and east, weather cloudy, and 2.23 inches of rain-fall. This was followed by clear weather, dry atmosphere, and high temperature until July 7, when a murky atmosphere, higher humidity, and south wind prevailed, and .32 inch of rain-fall, which condition continued until the commencement of the third application, namely, July 9. This was begun with high humidity, south wind, cloudy weather, high temperature, and a rain-fall of .41 inch for that day. For the two remaining days on which the third application was being made humidity greatly diminished, and a dry, clear, favorable condition prevailed and continued for several days immediately following.

The foliage of treated vines at the vintage was good as to the varieties treated with Bordeaux mixture, eau celeste (excepting the scorching of the Elvira previously alluded to), sulphatine, and David's powder; while the foliage of the untreated varieties in the above plats showed a comparative damage sustained of from 12 to 50 per cent.

As to plats treated with first simple solution of copper, the condition of the untreated portion exceeded in value by 10 to 15 per cent. The plat treated with the second simple solution of copper, the untreated vines exceeded in value those treated by not less than 50 per cent.

The condition of foliage two weeks before the usual time for the falling of leaves on treated vines (excepting the plats first and second simple solutions) was generally excellent, while that of the untreated vines had, in the case of the Delaware and the Vinifera hybrids, long since fallen to the ground, nor were there any varieties whose foliage did not clearly show that treatment was essential to success.

Ripening of wood.—This was best where the treatment was most effective, namely, Bordeaux mixture, eau celeste, David's powder, and sulphatine. I might say that some of the untreated varieties have ripened an abundance of wood for the next year's crop, but my experience of the last few years leads me to take warning from what were once regarded as resistant varieties, and are now classed as comparatively worthless without preventive remedies. But two years ago our Cynthiana and Norton's Virginia were regarded as thoroughly resistant, needing no treatment, but now none can be found to take this ground.

It was advised that daily records be kept of temperature, rain-fall, amount of dew, fogs, etc., and this I have been careful to secure from the volunteer meterological station at the University of Virginia, distant about 2 miles from me, and careful observations of my own prove that the variations between the two points are not of any consequence.

Day.	Daily mean temperature.	Daily mean relative humidity.	Barometer reduced to 32° F. at sea-level.	Weather.	Maximum temperature.	Prevailing wind.	Minimum temperature.	Rain-fall.
May 1	68.3	38	30.062	Clear	76	SSE.	52	For the month, 6.03; for the 24th to 31st, 2.57.
2	75.7	45	30.107	do	86	SE.	55	
3	79.7	53.6	30.182	do	89	SE.	59	
4	79.7	59	30.177	do	89.5	SE.	61	
5	76.5	61.6	29.987	do	85	NE.	64	
6	67	81.6	29.891	Clear and cloudy	81	SW.	65	
7	66	86	30.060	Clear and raining	74	N.	54	
8	60.5	82.3	30.096	do	74	NE.	54	
9	67	73.6	30.134	Cloudy, clear, and raining	74	E.	57	
10	64.2	91.3	30.144	Cloudy	71	NE.	60	
11	65.6	85.5	30.155	do	69	NE.	60	
12	75.7	61.6	30.118	Clear	84.5	NE.	53	
13	73.2	61	30.036	do	82.5	NE.	58	
14	64.7	43	30.315	do	76	NE.	55	
15	68.2	47.6	30.274	do	76	SE.	44	.00
16	69.5	60.6	30.134	do	80	NE.	46	.00
17	73.5	55	29.940	do	85	SE.	50	.00
18	76.3	50	29.864	do	84	N.	60	.00
19	73.6	64	30.030	do	83	N.	60	.00
20	74	54	30.231	do	84	SE.	58	.00
21	76.5	63.6	30.103	do	83	SE.	60	.00
22	72.2	62	30.187	do	80	SE.	57	.00
23	69.2	83.3	30.045	Clear and cloudy	75	S.	58	.00
24	69.7	83.6	30.684	Clear and raining	79	SE.	65	.23
25	70.5	73.3	29.758	Cloudy and raining	82	S.	57	.28
26	70.7	69	29.706	Clear and raining	77	W.	57	.18
27	62.3	75	29.761	do	73	NW.	50	.00
28	63.7	61.6	29.843	Clear	70	NW.	56	.00
29	68	57.6	29.922	do	75	N.	50	.00
30	63.5	80.6	30.109	Clear and raining	75	SE.	52	.62
31	64.5	83	30.015	Cloudy	70	SE.	60	1.26
June 1	62.5	92.3	29.963	Cloudy and rainy	72	SE.	54	1.06
2	68.7	74	29.896	Cloudy and clear	76	SE.	58	.49
3	74	58.3	29.927	Hazy and clear	79	NW.	65	.02
4	76.5	57	30.010	Clear	84	SE.	60	.00
5	73.2	74	30.169	Cloudy and clear	81	SE.	61	.00
6	64	96.6	30.212	Cloudy	75	SE.	60	.00
7	74.5	81.3	30.107	Clear and rainy	85	SE.	60	.45
8	73.7	82	29.801	do	81	SE.	67	.55
9	77.2	76.3	29.785	Clear and cloudy	86	SE.	62	.27
10	66.6	94.3	29.911	Cloudy	78	NE.	65	.105
11	62.2	50.6	30.256	Clear	68	NE.	54	.00
12	68.5	49.3	30.201	do	75	NE.	44	.00
13	72.7	59.3	30.060	do	84	NE.	48	.00
14	76.5	62	30.055	do	84	N.	62	.00
15	70.3	65	30.170	do	80	N.	54	.00
16	75.5	75	30.085	do	85	SE.	56	.00
17	83.2	57.3	29.829	Hazy and clear	91	S.	66	.00
18	82.2	61	29.729	Clear	93	SE.	69	.00
19	82	57	29.806	Hazy and clear	95	N.	69	.00
20	76.2	63.3	30.043	Clear and cloudy	93	N.	68	.10
21	79	75.3	29.912	Clear and hazy	88	SE.	65	.00

Day.	Daily mean temperature.	Daily mean relative humidity.	Barometer reduced to 23° F. at sea-level.	Weather.	Maximum temperature.	Prevailing wind.	Minimum temperature.	Rain-fall.
June 22	68	99	29.805	Clear and rainy	82	S.	64	.70
23	71.6	77.6	29.820	Cloudy and clear	78	E.	65	1.53
24	72.2	69.3	29.994	Misty and clear	81	N.	60	.00
25	71	63.3	30.234	Clear	77	NE.	67	.00
26	69.7	72	30.393	Hazy and clear	77	E.	56	.90
27	70.5	65.6	30.152	......do	79	NE.	51	.00
28	72.3	66.3	30.328	Clear	82	SE.	53	.00
29	75.3	60.6	30.296	......do	84	SE.	55	.00
30	77.7	63.6	30.247	......do	86	S.	58	.00
July 1	80.5	60.6	30.148	......do	89	S.	60	.00
2	78.7	67	30.146	......do	87	S.	64	.00
3	78.8	65.6	30.071	......do	85	S.	65	.00
4	78	72.3	30.146	Clear and cloudy	82	SE.	65	.00
5	79.6	72	30.012	Clear	86	S.	67	.00
6	60.2	78.6	30.013	......do	85	S.	71	.00
7	78	83.6	29.975	Murky and clear	85	S.	68	.32
8	74	83	29.894	......do	83	N.	69	.23
9	77	83.6	29.824	Cloudy	83	S.	68	.41
10	80.7	49.3	29.893	Clear	87	W.	70	.00
11	78.7	50.6	29.999	......do	88	N.	67	.00
12	80.7	55.3	30.093	......do	93	NE.	62	.00
13	83.2	65	30.028	......do	95	NE.	65	.00
14	80	67.3	30.174	......do	95.5	N.	64	.00
15	85.2	68.6	30.090	......do	94	S.	69	.00
16	85.5	68.6	30.022	......do	97	N.	73	.00
17	89.7	54	30.011	......do	99.5	W.	76	.58
18	88.2	60	29.921	......do	100	NW.	69	.00
19	82.7	74.6	30.011	......do	90.5	N.	72	.00
20	76.2	95	30.073	Cloudy and clear	88	NE.	73	.70
21	78	87.6	29.993	......do	89	SE.	75	.30
22	81	79.6	29.828	Clear	91.5	SE.	69	.00
23	76	81.3	29.909	Cloudy and clear	90	SE.	69	.17
24	74.7	89.6	30.077	Clear and rainy	81	NE.	71	.48
25	82.2	74	30.057	Cloudy and clear	89	E.	71	.00
26	77.2	83.6	30.041	Misty and clear	90.5	SE.	70	.03
27	60	81	30.015	Murky and clear	87	N.	69	.00
28	82	80.6	29.972	Clear	89.5	NE.	70	.00
29	87	73	29.983	......do	90.5	S.	71	.00
30	80.7	69.3	30.063	......do	90	S.	69	.00
31	79.7	77	29.994	Hazy and cloudy	87	NE.	73	.15
Aug. 1	76.5	95	29.661	Clear and windy	82	SE.	72	.05
2	74.2	98	29.965	Rainy and clear	79	E.	71	.55
3	79.2	81.3	30.048	Misty and clear	86	NE.	70	.00
4	78.5	77	30.119	Clear	85	E.	70	.00
5	80.2	75.3	30.019	......do	88	W.	71	.00
6	78.5	84.6	29.898	......do	89.5	SW.	*	.00
7	73.2	54.6	30.074	......do	81	N.	*	.00
8	72.2	65.3	30.259	......do	80	NE.	*	.00
9	74.7	71.6	30.242	......do	83	SE.	*	.00
10	79.2	70.3	30.093	......do	90	SE.	*	.00
11	83	67.3	29.982	......do	94	S.	*	.00
12	79	71.3	29.967	......do	92	NW.	70	.00
13	74.7	45	30.065	......do	80	NE.	68	.00
14	74	80.6	30.070	Rainy and clear	80	SE.	65	.00
15	74.2	86.6	29.846	Clear and windy	81	NE.	66	.13
16	76.7	77.3	29.858	Cloudy and clear	87	NE.	67	.10
17	72.5	85	29.978	Cloudy and hazy	86	SE.	62	.58
18	80	65.3	29.876	Clear	88	W.	69	.00
19	72.5	65.3	29.968	Cloudy and clear	88	E.	61	.00
20	76.2	78.3	30.150	Cloudy and hazy	87	NW.	62	.68
21	76	78.6	29.963	Hazy and clear	88	SE.	63	.00
22	75.2	84.3	29.496	......do	86	S.	69	.25
23	75.7	79.6	29.768	Cloudy and clear	87	NW.	66	.11
24	74	88.5	29.984	Clear	86	W.	61	.32
25	68	71.6	30.117	Clear and cloudy	76	NW.	57	.00
26	64.7	72.3	30.093	......do	71	E.	52	.00
27	65.5	83.3	30.300	Cloudy and rainy	67	NE.	57	.19
28	64.2	79.6	30.318	Hazy and clear	73	NE.	49	.00
29	64.2	61.6	30.276	Clear	73	E.	46	.00
30	65.2	64	30.309	Hazy and clear	77	NW.	45	.00
31	66.5	63.6	29.987	......do	76	E.	49	.00
Sept. 1	67.2	72.3	30.262	......do	77	NW.	47	.00
2	72	62	29.877	......do	85	SW.	51	.00
3	73	66.6	30.155	Clear and cloudy	83	N.	57	.00
4	68.5	57.6	30.346	Clear	76	NE.	57	.00
5	67.5	66	30.378	Hazy and clear	79	SE.	46	.00
6	73.7	65	30.133	Clear and cloudy	85	S.	53	.00

Day.		Daily mean temperature.	Daily mean relative humidity.	Barometer reduced to 32° F. at sea-level.	Weather.	Maximum temperature.	Prevailing wind.	Minimum temperature.	Rain-fall.
Sept.	7	72.5	74.6	29.840	Cloudy	83	SE.	63	.00
	8	68.2	50.6	29.930	Clear	78	NW.	57	.00
	9	68.2	65.3	30.112	Hazy and clear	78	S.	45	.00
	10	75.2	59	30.112	Clear	90	N.	60	.00
	11	62.7	74	30.292	Hazy and cloudy	76	NE.	59	.00
	12	76.7	78	30.144	Cloudy	85	SW.	60	.00
	13	74.7	91.3	30.137	Fog and clear	86	NE.	66	.00
	14	76.2	83.3	30.152	do	91	W.	67	.12
	15	71.2	82.3	30.213	Fog and cloudy	79	N.	65	.00
	16	65	64.6	30.312	Misty and hazy	75	NE.	50	.00
	17	59.2	62.6	30.459	Misty and cloudy	69	N.	47	.00
	18	59.7	78	30.453	Hazy	65	N.	49	.00
	19	66.2	80.6	30.402	Hazy and cloudy	73	NW.	57	.00
	20	68.5	80	30.349	Fog and hazy	81.5	NE.	49	.00
	21	66	67.3	30.241	Fog and clear	84	S.	50	.00
	22	75.7	55.3	30.045	Clear	88	S.	58	.00
	23	59.6	63	20.972	Cloudy	78	N.	57	.00
	24	49	44.6	30.313	Clear and hazy	66	N.	41	.00
	25	50.5	57.6	30.347	Hazy	61	W.	34	.00
	26	54.7	64	30.172	Clear and hazy	66	SE.	32	.00
	27	52.7	88.6	30.166	Hazy and rainy	61	S.	42	.11
	28	55.7	97.6	30.156	Rainy	57	N.	51	1.56
	29	65.2	97.6	30.118	Rainy and fog	69	N.	56	.54
	30	73.5	73.6	30.022	Cloudy and clear	80	S.	65	.31
Oct.	1	68.5	58.3	30.019	Clear	77	N.	57	.00
	2	68	63.3	29.967	do	79.5	S.	48	.00
	3	66	58.6	29.841	Fog and clear	77	NW.	56	.00
	4	61.5	58.3	29.750	Clear	72	SW.	56	.00
	5	56	50	29.864	do	63.5	NW.	56	.00
	6	59.5	64.6	30.140	Hazy and clear	65	SE.	38	.00
	7	67.2	60	30.328	do	80	SE.	44	.00
	8	70.7	61.6	30.177	Fog and clear	84	E.	45	.00
	9	74	54.6	30.031	Clear	84	N.	56	.00
	10	78.2	53.3	30.016	Clear and cloudy	86	W.	66	.00
	11	55	68	30.039	Cloudy	80	N.	57	.02
	12	51.5	53.6	36.224	Clear	66	NW.	42	.00
	13	55.7	58.3	30.091	Misty and clear	68	S.	36	.00
	14	53.7	54	30.223	do	63	NW.	38	.00
	15	47.2	53.6	30.504	do	58	N.	32	.00
	16	51.5	61.3	30.485	White frost and clear	63	S.	26	.00
	17	62	64.3	30.251	Cloudy and clear	73	S.	36	.00
	18	60.7	94.3	30.101	Cloudy	72	E.	43	.32
	19	60.2	83.6	30.058	Fog and hazy	66	E.	53	.00
	20	53.2	97.6	30.002	Rainy	62	N.	52	1.28
	21	57.7	44.6	29.894	Clear	58	W.	48	.00
	22	64	37.3	30.250	do	57	NW.	35	.00
	23	54.5	47.6	30.237	do	65	S.	31	.00
	24	59.2	69.3	30.161	do	65	S.	52	.00
	25	35.5	94	30.126	Rainy	60	N.	39	1.02
	26	42.2	83.6	30.591	Cloudy	44	NE.	33	.05
	27	46.7	100	30.456	Rainy	49	N.	40	.32
	28	51.5	95.3	30.338	Cloudy	54	N.	46	.00
	29	55	81.3	30.118	Hazy and clear	64	NE.	46	.00
	30	43.2	80.3	30.083	Rainy and clear	59	NW.	44	.50
	31	46	32	29.969	Cloudy and hazy	52	N.	34	.00

Early in June (10th) I received your request to experiment with eau celeste containing double the amount of water prescribed in the formula given in your letter of instruction. In fulfillment thereof, I selected a plat of Catawbas numbering 200 vines, and reserved 40 untreated as a control experiment. At the time of treatment the weather was cloudy, atmosphere very damp, which was immediately followed by several days of clear weather, high temperature, and dry atmosphere. The effect upon the foliage at the time of the second application, which was June 24, was at least 20 per cent. in favor of the treatment, and at the time of the third application, namely, July 6, it was at least 35 per cent. in its favor. The difference in the ripening of the wood was equally great in favor of the treated vines as compared with the non-treated.

No scorching of foliage resulted from the application of this remedy thus prepared. In respect to black rot a small advantage (from 10 to 12 per cent.) certainly accrued to the treated vines.

Black rot.—Under instructions received June 15, I prepared the following formula: Half ounce phenic acid in crystals, 20 gallons of water, and applied the same directly to the bunches of grapes, having first removed all diseased berries. June 29 the vines were gone over again and all diseased berries taken therefrom and a second application of the preparation was made. No benefit whatever could be claimed as resulting from this treatment.

June 20 I received instructions to prepare a remedy by the following formula: Two ounces phenic acid in crystals, 2 pounds common hard soap, 22 gallons of water, and to apply the same directly to the bunches of grapes with an atomizer. For this experiment I selected a plat of Champions, containing 500 vines, and having first gone over each bunch and taken therefrom all berries showing any stage of rot to the naked eye (which were sufficient to fill a 15 pound grape basket), I then made a thorough application of the remedy. The diseased berries taken from the bunches before the harvesting of the crop, which was early in August, measured but 1 pint. In making this statement of a carefully observed fact, I abstain from any remark.

Respectfully,

H. L. LYMAN.

HON. NORMAN J. COLMAN,
Commissioner of Agriculture.

SUPPLEMENTARY REPORT OF EXPERIMENTS MADE BY MR. LYMAN.

SIR: In accordance with instructions issued by the Department of Agriculture, I began my general vineyard treatment, using the copper mixture of Gironde, which was prepared by the following formula:

Twelve pounds of sulphate of copper, 22 gallons of water; in another vessel slake 20 pounds of lime in 6 gallons of water, etc. I began this application June 4, in clear weather, with dry atmosphere, southeast breeze, and mean temperature of 75.5, the maximum being 84 degrees. The work begun was not finished until the close of June 8, during which time cloudy weather prevailed, the humidity had run up to 96.6, and 1 inch of rain had fallen. The first and second days succeeding this first application were characterized by cloudy weather, damp atmosphere, and .37 inch rainfall; the third and fourth days were clear, with dry atmosphere and northeast breeze. For the application of this remedy to vines planted upon level ground I had mounted a pipe on wheels and attached to it the double spraying apparatus made by the Field Force Pump Company, of Lockport, N. Y., and had secured through you two Vermorel nozzles to be used therewith. For the hilly lands and narrow places I had the remedy conveyed in ordinary wooden buckets, and used a plantation-made hand-broom with which to apply it.

I reserved untreated a section of Norton's Virginia, which on the 20th of June showed mildew so generally as to constrain me to apply the copper mixture there also, so well convinced was I of the damaging results which would follow their further neglect.

A second application to the general vineyard was begun June 27, with atmosphere clear and dry, and the temperature ranging from 79 to 89 degrees maximum, which weather continued to the close of the application and for the four days immediately following.

As to the condition of foliage and ripening of wood of the vines above referred to, I have for a result all that could be desired as to wood. The per cent. of the mixture upon the dead leaves beneath the vines evinces a staying or enduring quality in the same.

With respect to black-rot, the Concord and Catawba section of this succumbed wholly to its ravages, while the Ives and Norton's Virginia returned me a full and excellent crop.

Permit me now to remark that the ease with which the copper mixture is prepared, the slight risk incurred of oversight in application by hands of only moderate intelligence, and its staying qualities, all cause me to esteem it very highly.

Bagging.—A section of Delawares was left out for this experiment, which was undertaken at three different stages of development, namely, before blooming, after fertilization, and when the berries had attained the size of buck shot. Before the date for determining this experiment mildew had started so actively at work upon the foliage that I applied eau celeste, composed of sulphate of copper, 1 pound; ammonia, 1½ pints; and water, 44 gallons, which application I again repeated three weeks afterwards. This treatment resulted in checking the mildew, thereby saving the foliage and securing excellent wood for the ensuing year's crop. On removing the bags from the bunches I found the following result with respect to their efficacy, namely, the bags put on before blooming were successful in keeping off all enemies. Those put on immediately after fertilization resulted in a loss of about 12½ per cent. Those applied at the third stage of development resulted in a loss of from 27 to 35 per cent. This latter experiment has taught me the lesson that hereafter my application of remedies must be begun earlier, as other hurtful agents than those made known to me at the first appearance of mildew and black-rot had already been at work.

Respectfully,

H. L. LYMAN.

Hon. NORMAN J. COLMAN,
Commissioner of Agriculture.

EXPERIMENTS AT VINELAND, N. J.

SIR: I have the honor to submit the following report of experiments made by me in accordance with your directions, in the treatment of mildew and black-rot of the grape.

The vines subjected to these experiments are of the variety known as Concord. They have grown in the vineyard sixteen years. They are pruned on the "renewal system," and are trained on trellises of a single wire 2½ feet above the ground. Summer pruning has not been practiced. The vineyard has been sparely fertilized with barn-yard manure, phosphate of lime, potassa and lime. It has been more or less diseased with downy mildew (*Peronospora viticola*) and with black-rot (*Physalospora*) yearly since 1872. The vines stand in eleven parallel rows running north and south, rows 9 feet apart, vines 6 feet distant from each other in the rows. There are 110 vines in each row.

To test comparatively the efficacy of the five compounds of copper sulphate, formulated in the Department circular, five equal sections of this vineyard, crosswise of its rows, were allotted to the five compounds employed. To the southern or first section the simple solution of sulphate of copper was applied; to the next or second section, eau celeste; to the third section, Bordeaux mixture; to the fourth section, David's powder; to the fifth section sulphatine. The sixth or middle row of the eleven rows in the vineyard, traversing all these sections, was left untreated for comparison.

The first application was made on June 13, 1887, under the personal supervision of the Chief of the Section of Vegetable Pathology.

The solutions of copper sulphate were applied to the vines by means of the Vermorel spraying apparatus, imported from France by the Commissioner of Agriculture for use in these experiments. David's powder and the sulphatine were distributed with ordinary sulphuring bellows.

The weather on and immediately previous to June 13 was clear, cool, and dry. There were no symptoms of fungus disease, excepting a slight development of the fungus of black-rot on the foliage of the Concord.

MEMORANDA FROM MY DIARY.

June 13, 14, *and* 15.—Clear, generally cool, and atmosphere dry; wind N. E.

June 16.—Clear, cool; foggy at sunrise.

June 17 *to* 21.—Clear and hot during the day; heavy rains during the nights of the 18th and 20th. Found specks of black-rot on Clinton grapes on the 19th, and on the 21st observed much rot on the treated Concords.

June 22 *and* 23.—Warm, with a rain-fall of 6 inches in the 48 hours.

June 24.—Fog at sunrise, day clear; everything is saturated, even to the wall-paper in my room, which appears wet, as though freshly hung. Black-rot is visible all over the experiment vineyard. I see no effect from the spraying, except that the simple solution has scorched the foilage considerably, as also has eau celeste.

June 24 *and* 25.—Clear and cool.

June 26.—Clear, warm; rain p. m.

June 27.—Clear, cool.

June 28.—Clear, warm. Sprayed the north half of section No. 1 with solution of phenol and soap, to try it as preventive of black-rot, which is rapidly spreading.

June 29.—Clear, hot. At 4 a. m. I dusted the vines of south half of section No. 1 with carbolate of lime. Black-rot has destroyed two-thirds of Concord grapes in experiment vineyard and elsewhere.

June 30 *to July* 5.—Clear, hot; rain during p. m. of the 5th.

July 6 *and* 7.—Very humid atmosphere; cloudy and hot.

July 8.—Fog a. m., cleared at 10 a. m.; very hot. Fresh rot specks continue to appear. No signs of mildew as yet.

July 9.—Cloudy, warm; hard rain p. m.

July 10 *to* 15.—Clear; temperature high. On the 15th found mildew for the first time on leaves of the Ironclad grape, and on a few of the newly-formed leaves in experiment vineyard. No mildew on leaves which have been sprayed with the solutions of copper sulphate. The Bordeaux mixture and eau celeste, applied June 13, are yet visible on the foliage.

July 16.—Clear, hot; 100° in the shade. The black-rot has stopped spreading. I find no fresh rot specks on the grapes. Made solutions of the copper sulphate for second treatment. Increased the dilution of the simple solution from 22 to 36 gallons of water to 1 pound copper sulphate.

July 17.—Clear, hot, 104° in the shade.

July 18.—Clear, hot. Made second application of the solutions and powders to experiment vines. There is much mildew visible, but confined to leaves which have grown since June 13.

July 19.—Cloudy, warm; rain last night.

July 20.—Clear, cooler.

July 21.—Cloudy, warm; very damp atmosphere. Fresh rot specks are visible on the Concords.

July 22.—Fog a. m.; very moist and sultry. Grapes rotting again by wholesale. Concords are almost totally infected. Some little fresh rot on the Ives; also on Noah and Norton. No rot on Elvira, nor on Ironclad. Neither has as yet a rotting berry, though fruiting close to rotting Concords. Cottage has rotted but little. Conqueror and Berckmans have not rotted any. Concords of experiment vineyard are rotting badly in each section. Apparently there are a few more sound berries where dusted with the powders. The foliage of the various sections shows but little mildew excepting on the unsprayed row. On leaves infected by mildew the parasite seems not to spread since application of the preventives, and the patches of mildew already on the leaf are withering, apparently destroyed by the copper sulphate. A few of the mildewed leaves were immersed in the Bordeaux mixture and also in eau celeste. Shortly after the bath the fungus growth changes color and seems to shrink. Evidently the solutions kill it. Neither of these solutions nor that of phenol and soap have had effect in preventing the black-rot. The simple solution and the eau celeste burn the tender growth of the vine. No damage apparent from the Bordeaux mixture. The sulphatine also scorches the foliage a little. All the mixtures seem about equally preventive of mildew. The Bordeaux is preferable, as it is evidently less harmful.

July 23 *and* 24.—Cloudy, hot, damp; heavy rain p. m. and all night; 5 inches of rain fell.

July 25 *and* 26.—Fog at sunrise; cleared off very hot and moist. On the 26th few of the Concord grapes in the experiment vineyard have escaped the rot. Perhaps two or three berries in some clusters. Nine-tenths of the bunches are totally destroyed.

July 27 *to* 31.—Clear, hot, and weather generally very damp; rain last night.

August 1.—Partly cloudy, sultry and humid; the air heavily loaded with moisture. Plenty of mildew now except where leaves have been sprayed with the solutions of copper sulphate.

August 2.—The Ives seedling and Ironclad are beginning to color. I find a few rotted berries on the Ironclad and considerable mildew on its foliage, but plenty of sound leaves left. There has been no fresh rot for some time on Ives or on Norton. When these grapes reach a certain stage of development they are seemingly "rot proof." Elvira remains healthy; so do Conqueror and Berckmans.

From the 2d to the 17th.—The weather generally favorable for the development of fungus diseases, being generally hot and moist with occasional lowering of temperature.

August 17.—Made the third and last application of solutions and powders to the experiment vineyard, at this time the grapes being all rotted. Some mildew on all the rows, but it is much worse on the row left untreated.

It is needless to prolong this record; I merely advert to the evidence of the remarkable humidity of the season: "the wettest summer ever known in southern New Jersey." If heat and moisture favor the development of mildew and grape rot, these surely never flourished under better conditions. The remainder of August was unusually warm and wet. September was more dry, but with heavy dews and frequent fogs. Such conditions are believed to promote mildew; yet at this date (October 2) the foliage of the experimental vineyard remains bright and green, except the middle row left untreated, and of which the leaves, shriveled and browned by mildew, are now in noticeable contrast to the others.

CONCLUSIONS.

The conclusions drawn from these experiments are that the copper sulphate may ordinarily be relied upon as a preventive of grape mildew, and that of the formulas experimented with, the Bordeaux mixture is preferable as being fully as efficient and the least harmful to the vine. I shall resort to it exclusively in future, satisfied that by its timely and frequent use serious damage from grape mildew may be avoided. Three or more applications of this solution, the first to be made as soon as the vine leaves are grown, and to be renewed once in four weeks until the fruit begins to ripen, will be fully protective.

French authorities state that the copper sulphate is protective to some distance (10 to 12 inches) around where it is present; that stakes dipped in a saturated solution of the disinfectant were observed to protect vines fastened to them. Under our conditions this is not so. May 6, 1887, when Concord vines began to open their buds, I applied the Bordeaux mixture to several rows of trellises in a vineyard apart from that devoted to the general experiments, washing thoroughly vines, posts, and wires with the copper solution. I also thus treated a portion of another vineyard where the vines were wound around stakes. When the mildew appeared, the foliage nearest the disinfected stakes was as promptly attacked as was that more distant, and clusters of grapes resting against these stakes rotted readily and totally, as did those not "protected."

The leaves of the vine, however, which were wet with the Bordeaux mixture in June, have been thus saved from mildew during the summer, and the presence of the mixture is still discernible (October 2) upon these leaves. As the vines grow, new leaves form and these will be attacked by mildew, though located contiguous to leaves covered and protected by the copper sulphate. Hence I infer that under our conditions the applications should be repeated at intervals sufficiently frequent to secure to each new leaf the actual presence of the copper sulphate on its surface. This is well done by the Vermorel machine, with which one man can spray from three to five acres of vines per day. Of course the final treatment, when vines have extended their growth, will consume more time and material than the first.

Experience will teach what strength of copper sulphate is required in the Bordeaux mixture. Sixteen pounds of copper sulphate dissolved in 22 gallons of water, and mixed with a solution of 20 pounds lime in 6 gallons water, was the formula used. Possibly much less of the copper sulphate may be found to be sufficient. The simple solution (1 pound of the sulphate in 25 gallons water) is efficient against mildew, but too strong for the foliage; the acid of the sulphate must be fully neutralized by some alkali, and this neutralization seems better effected by the lime in the Bordeaux mixture than by the ammonia in eau celeste. This latter is also protective against the mildew, but under some circumstances burns the leaves. The formula used was 1 pound of copper sulphate diluted in 26 gallons water, and 1 pint commercial ammonia added. The diluted fluid is nearly the same in each of the three mixtures; they seem nearly equally protective. Hence I see no reason for the excess of copper sulphate in the Bordeaux mixture. Possibly the amount of sulphate of copper may be diminished without detriment, and I propose trying, hereafter, the Bordeaux mixture diluted with four times the usual amount of water.

Certain varieties of the vine are peculiarly susceptible to injury from the copper sulphate. Soon after being sprayed with eau celeste, the Norton shed most of its leaves, while a luxuriant Cynthiana was totally denuded of fruit and foliage. Herbemont was likewise damaged. Concord, Ives, and Ironclad were not harmed excepting a slight scorching of the young shoots. Dusting with sulphatine was equally hurtful to the Norton.

A preventive of black-rot remains to be discovered. There can be no *cure* for this malady, for the fungus grows and fructifies beneath the skin of the grape. The infecting germs must be excluded. If they ente the grape they are masters of the premises.

To test the *preventive* efficacy of the copper sulphate for black-rot, I immersed clusters of Concords in the solutions used. I also immersed others in the solution of phenol and soap. These grapes rotted equally with those not so treated. *Probably infection had taken place previous to immersion.*

The only evidence of the prevention of black-rot in the experiment vineyard was in the sections treated with the powders, especially with the sulphatine, which, from its more complete comminution was best applied. Here a few clusters partially escaped ruin. I think that the sulphatine prevented infection merely by interposition of its particles between the infecting germ and grape skin. Any other dust might have done as well. So long as the grape is covered with dust it is protected. When this dust is washed off the omnipresent germs of *Physalospora* enter at once. However, there are some points relative to the question of the infection which are difficult of solution and demand further careful study.

It will be of interest to viticulturists that I mention an observation made accidentally during treatment of the vines with copper sulphate.

This spring (1887) our vineyards were invaded by rose-bugs. They came in irresistible force, entering the west side of my farm. Where they depredated, they stripped every cluster from some three thousand of my vines, but they did not reach the experiment vineyard, on its east side. When I completed the first treatment of the experiment vineyard, I employed the residue of the solutions upon this west vineyard, then swarming with rose-bugs. Passing along the rows of sprayed vines next morning I noticed that from them the rose-bugs had departed, while they yet infested vines unsprayed. This indicates that the copper sulphate may be inimical to this formidable foe to the grape-vine.

Respectfully,

ALEX. W. PEARSON,
Special Agent.

Hon. NORMAN J. COLMAN,
Commissioner of Agriculture.

CHART OF MR. MUNSON'S VINEYARD, SHOWING E ROWS
ARE LET

	1	2	3	4	5	6	7	8	9	10	11	39	40	41	
	Bordeaux mixture applied May 7 and May 29.					No treatment.	Bordeaux mixture applied M and May 29.					o treatment.			
a															*a*
b															*b*
c															*c*
d															*d*
e															*e*
f	1	1	1	1	1	1¼	1	1							*f*
g				1		1¼									*g*
h	1½	1	1									¼			*h*
i															*i*
j															*j*
k															*k*
l															
m						1									*m*
n			1	1	1	1¾	1	1	1	1			1		*n*
o															*o*
p															*p*
q				1		1		1	1	1	1½	2 1		2	*q*
r		2	2	2	2	2½	2½	2	2	2	2	1	1	1	*r*
s	1	2	2	1	1	1	1	1	2 1						*s*
t									1						*t*
u									1						*u*
v									1						*v*

EXPERIMENTS AT DENISON, TEXAS.

SIR: In accordance with your instructions I have the honor to submit the following report of experiments conducted by me under your direction in the treatment of the diseases of the vine.

To make my work more easily understood, and to enable one to draw correct conclusions, I have designed a chart of my vineyard, herewith presented, which shows: 1st. The kind of remedies employed, prepared according to the printed formulas received from the Chief of the Section. 2d. Number of applications made, and date of each. The rows are lettered from *a* to *y*, and the vines in each row are numbered from 1 to 41, permitting ready reference to any vine or row.

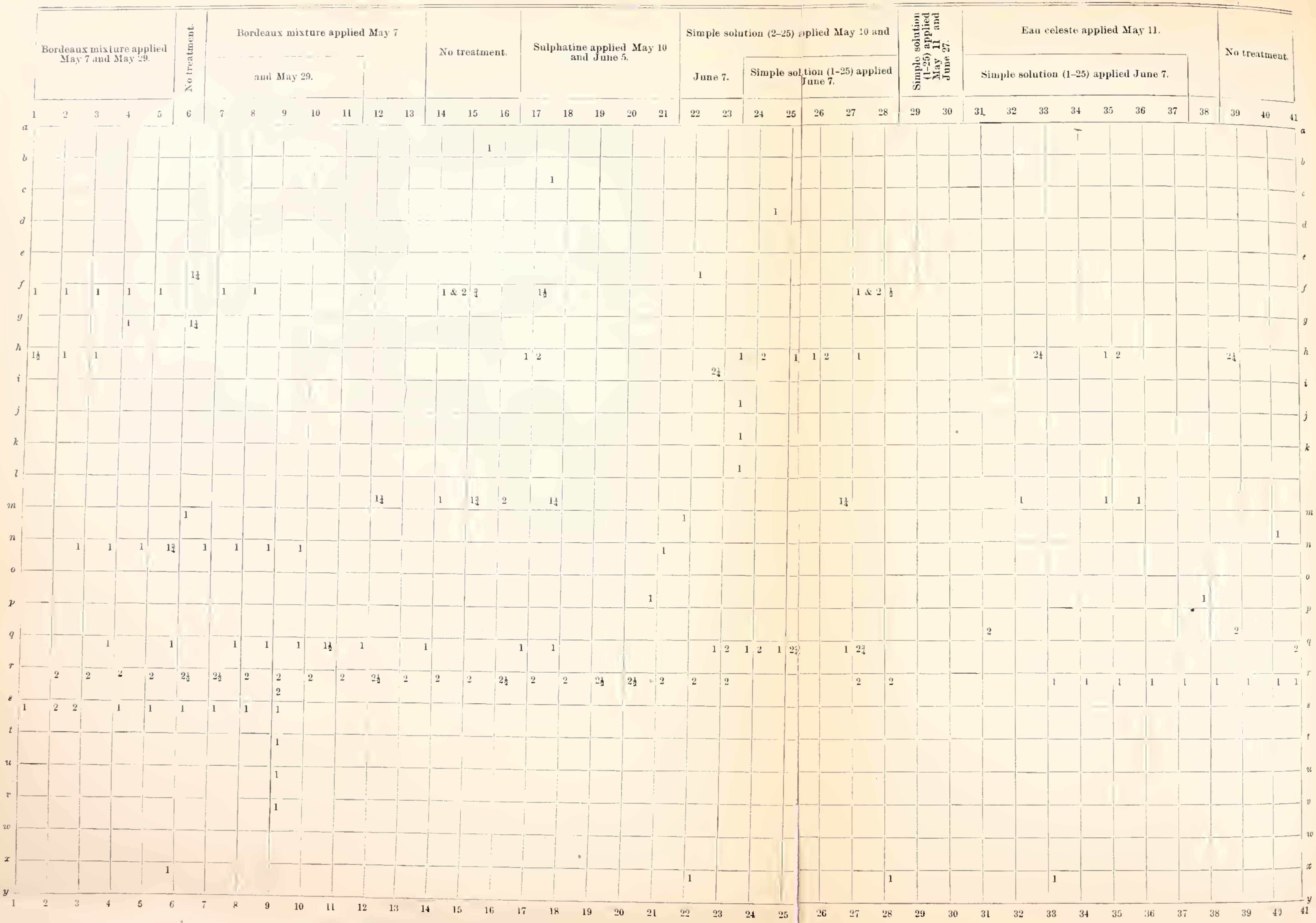
The vineyard in 1885, a very wet season here, set a good crop of fruit, but the Concord, Brighton, Champion, most of Rogers, Hybrids, Duchess, Irving, and Lady Washington rotted so badly as to unfit them for market, while Perkins, Ives, Delaware, Elvira, Triumph, Herbemont, Moore's Early, and Martha rotted much less and were fairly marketable, Delaware, Ives, Perkins, and Cynthiana rotting the least—scarcely any.

In 1886 the vineyard bore a fair crop; the season was unusually dry from the last of April, and little rot appeared except in Brighton, Duchess, Barry and Rogers No. 2, all of which were destroyed by rot, as they always have been until the present season.

The vineyard has been well cultivated but never manured, the vines always growing strongly enough. The pruning has been to short spurs, the training to posts, and thence laterally upon wire drawn tightly from post to post north and south, and the vines headed high, as it was observed that less rot usually appeared high up than near the ground. The bulk of fruit was borne at a height of about 4 feet from ground.

When the first applications were made, in the evening of May 7, the vines were in excellent health, the Herbemont just beginning to bloom (a week or ten days earlier than usual). The Concord had berries as large as No. 5 or 6 shot, while those of the Champion and Ives were as large again. No signs of rot or mildew existed anywhere in the vineyard. The spraying was thoroughly done under strong pressure in the syringe so as to force the spray to every part of the leaves, fruit, and even vine and post surfaces; there were a few vines so full of leaves that it was impossible to reach every cluster and berry; especially was this

CHART OF MR. MUNSON'S VINEYARD, SHOWING THE KIND OF REMEDY USED, NUMBER OF VINES TREATED AND THE NUMBER AND DATE OF THE APPLICATIONS. THE ROWS ARE LETTERED FROM "*a*" TO "*y*," AND THE VINES IN EACH ROW ARE NUMBERED FROM 1 TO 41.



18242—Bull. No. 5, Botanical Division, Department of Agriculture.

the case in the Goethe vines "1" to "12," in row "R," a point where that variety rotted worst; but the soil in this part of the vineyard was wetter than at other points where this variety is planted. The sulphatine was thoroughly applied with the Woodason bellows.

The following, copied from my diary, will aid in comprehending the effects of the various treatments:

May 7.—Prepared Bordeaux mixture and made first application.

May 10.—Made first application of (1) sulphatine and (2) sulphate of copper (simple solution 2 pounds to 25 gallons water), as shown in chart.

May 11.—Applied sulphate of copper (simple solution, 1 pound to 25 gallons of water) and eau celeste, as shown in chart.

May 12.—Prepared David's powder, and set to dry.

May 18.—Find a few berries of Brighton showing rot, both on vines treated with Bordeaux mixture and on untreated vines. The leaves and sometimes the fruit of all varieties on which the simple solution No. 2 (2 pounds sulphate of copper to 25 gallons water) was applied, appear to be scorched, as by fire.

David's powder does not dry out, but remains sticky, no matter how much I try to dry it with sun and fire heat. Prepared another batch of David's powder.

May 20.—Weather has been cooler than usual at this season of the year. Observed a number of berries on Brighton and Lady Washington and a few on Concord and some other varieties, attacked with rot, both where the Bordeaux mixture and other applications were made, as well as where no treatment was given. The simple solutions and eau celeste have scorched both leaves and fruit, the No. 2 (2 pounds sulphate of copper to 25 gallons water) much the worst, so as to partly defoliate the vines.

May 24.—Second batch of David's powder refuses to dry.

May 25.—Weather favorable to rot and mildew. No mildew yet noticed in vineyard, but appearing on young plants, in seed bed, of *V. Californica*, *V. Arizonica*, *V. vinifera*, *V. Romaneti*, *V. Davidi* (the last three Asiatic species, natives of high altitude). All other American species but little touched with mildew. As a rule all species of *Vitis*, natives of high and dry altitudes, growing in my grounds are much more subject to mildew, anthracnose, and other fungous diseases than those native of low and moist regions.

May 27.—Duchess, Irving, and Brighton grapes rotting severely where no applications have been made, and more or less where all applications except the Bordeaux mixture were applied. Where the Bordeaux mixture was used the rot, seen in a small way a few days ago, has entirely ceased, although the entire vineyard was not critically gone over to make observations. Rot is less prevalent in the vineyard than ever before at this season, under equally favoring conditions for its developments.

June 5.—Made second application of sulphatine, as shown in chart. Very few rotten berries found on vines treated with sulphatine before, as also where the 2-pound solution of sulphate of copper was used.

June 7.—Applied simple solution (2 pounds to 25 gallons) to rows 22 and 23, only the second time, as the first application had burned so badly as to injure the crop already. Applied solution, 1 pound to 25 gallons water, to rows 24 to 37 inclusive, as eau celeste has also burned the leaves badly. Zinfandel, a pure Vinifera variety, not treated, standing in a young vineyard below the one chartered, entirely rotten in the past few days. Newark, a Labrusca-Vinifera hybrid, also nearly all rotten in same vineyard, and all varieties in this younger vineyard, of which there are some in the old treated vineyard, have rotted worse than where treated.

June 11.—Rot to this period is designated on the chart by the figure 1.

June 27 *to July* 11.—Thermometer running from 70° and 80° at 6 a. m. to 90° and 100° at 2 p. m., with much rain, seemingly favorable weather for rot, and much rot prevailed. The fruit in some Concord vineyards in the vicinity of Denison entirely destroyed by rot, others damaged but little. Vines in deep, rich, sandy soil suffering worst, those in high, well-drained red clay soils least. This period of rot is designated on the chart by the figure 2. During this time I marketed in good condition Champion, Moore's Early, Lady, Brighton, Delaware, Ives, Perkins, Martha.

The leaves treated with Bordeaux mixture are apparently healthy and yet retain considerable of the mixture, especially on their under surfaces. Leaves where sulphatine was used somewhat yellowed, especially in varieties of the Æstivalis species. Leaves where simple solution (2 pounds to 25 gallons water) and eau celeste were applied, mostly dropped off and new leaves coming; the vines worst affected are not ripening their fruit well.

July 12 *to August* 5.—Dry and hot; no rot.

August 5.—Marketed Herbemonts on which closes out my crop. Leaves where Bordeaux mixture was used are still healthy and retain some of the mixture, while on vines where the solutions took the leaves off new leaves have appeared again and the vines doing well. Had the air been more moist when these applications were made the leaves would not have been so badly scorched, I am sure.

CRITICAL NOTES OF RESULTS TAKEN IN THE VINEYARD JULY 6 AND 7.

Referring to the chart for full record. Rows *a*, *b*, *c*, *d*, all Concord; a few berries shriveled by rot (1), less where Bordeaux mixture was used than elsewhere. No rot (2) observed. Nearly every season here we have the two periods of rot corresponding with two rainy, sultry periods, the dry windy weather intervening, checking the first attack.

Row *e*, 1 to 40, except 21st, Perkins; no rot; marketed July 6.

Row *e*, No. 41, Hartford; untreated; no rot.

Row *e*, No. 21, treated with sulphate copper (2 pounds) and sulphatine.

Row *f*, 1 to 7, Brighton; Bordeaux mixture; little rot in the first attack, none in the second. Sixth vine untreated, ¼ 1.

Row *f*, 8 and 9, Lady Washington; little rot in the first attack, none in the second.

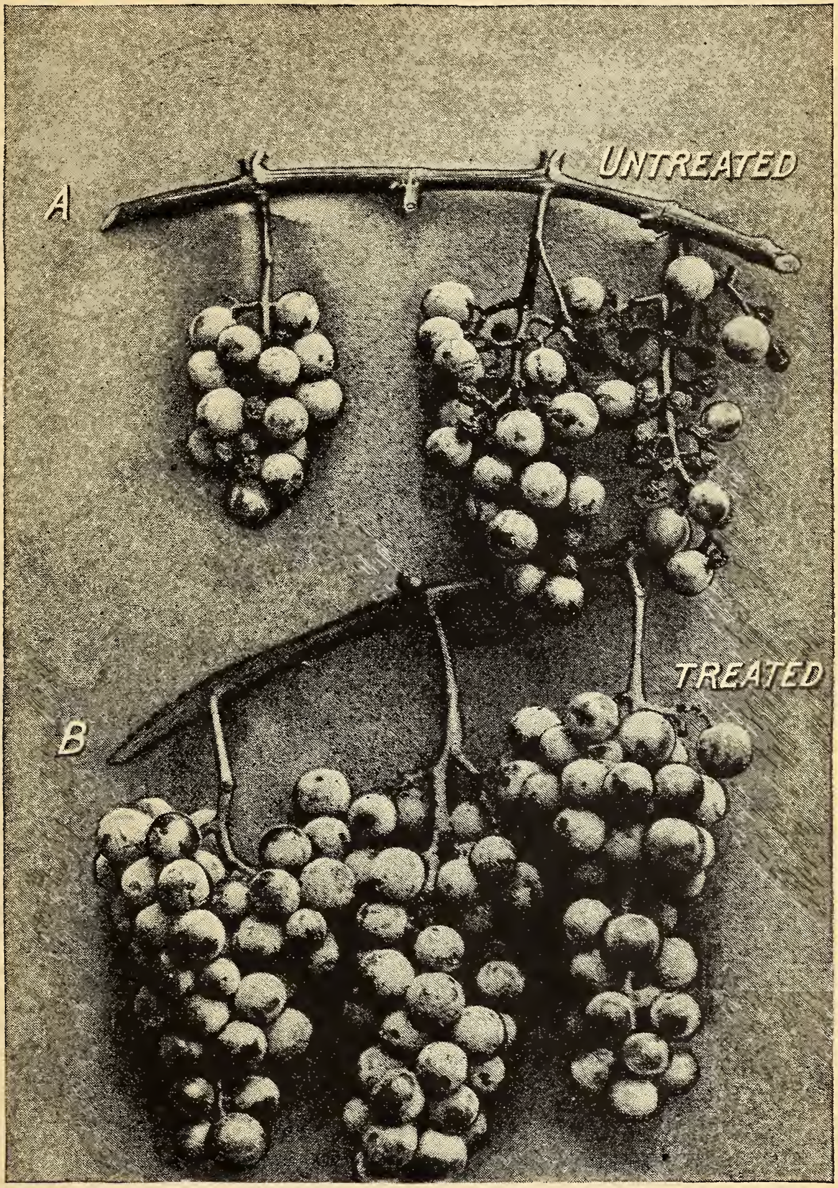
Row *f*, 10 and 11, Noah; treated vines with Bordeaux mixture; no rot.

Row *f*, 12 and 13, Noah; treated once with Bordeaux mixture; no rot.

This is sufficient to enable any one to read the chart and glean the results. The figures 1 and 2, or both, being placed by a cross line or a variety name in the chart, show to what extent the fruit of the vine or variety there suffered by the first or second periods of rot, or both. If no such figure is found no rot was observed. As no mildew was observed in the vineyards, I make no further reference thereto. If by a vine or variety in the chart a figure 1¼ is found, it means that about one-fourth the crop was destroyed by first rot, if then 2½ or 1¾ it would mean that one-half of the crop was destroyed by rot 2, or three-fourths by rot 1. If simply 1 or 2, or both, be found with no fraction attached, there was still a good marketable crop of fruit matured after being affected somewhat with either of the periods of rot as shown.

SPECIAL VINES AND VARIETIES.

In the study of the chart and the actual results in the vineyard there seems to be positive evidence of preventive effect in the use of the different preparations of sulphate of copper, especially in the early applications, the Bordeaux mixture giving most evidence of efficacy. This is especially seen in certain varieties, the Brighton in particular. I here present a photograph of a branch (*a* in plate) taken from vine No. 6, in row *n*, in chart, untreated and a branch (*b* in plate) taken from vine No. 5, row *n* in chart, treated with Bordeaux mixture. These branches and clusters fairly represent the crops on untreated and treated Brighton at that place in the vineyard, and I can discover no other probable cause of the difference than the remedy used. I had a good marketable crop of Brighton this year, whereas I never saved any heretofore although passing through seasons less favorable to rot. But on the other hand the fact that Lady Washington (No. 11, row *q*) and Goethe (*r*, 6, 7, 12, 16, 19, and 20) lost half their crop whether treated or not, weakens the effect of the facts concerning Brighton. But we find at this point in vineyard heavier foliage, wetter soil, less probability of having reached all parts with spray or powder, and hence the greater rot here. Still, there is Lady Washington of these last (*q*, 11, in chart), which I remember having sprayed thoroughly and heavily all among leaves and fruit, and still it lost half its crop, and Rogers No. 2, on dry ground (*q*, 23, 24, 25, 26, and 28, in chart), which lost three-fourths or more of its crop



EFFECT OF TREATMENT ON BLACK-ROT.
(FROM PHOTOGRAPH.)

as usual, yet it was well sprayed and lost part of its foliage by treatment with simple solution.

Strangely enough Brighton, in row *n*, numbers 39, 40, and 41, untreated, were as free from rot as 34, 35, 36, 37, and 38, in same row or elsewhere, with the various treatments. Another fact may bear on this somewhat: It is, that whenever rot first attacks my vineyard, and others noticed here, it strikes most upon fruit on east and south side of vines bordering the south and east sides of vineyard, that being the direction from whence come the prevailing winds. These untreated and unaffected Brightons were on the north side of vineyard. But again, Eumelan (at *z*, l, in chart), which heretofore always rotted, was not affected this year. This vine, in the southernmost row, was open, hung full of fruit, and hence just so conditioned as to be most easily attacked. I made it a point to thoroughly spray it with both first and second applications of Bordeaux mixture. The crop came off perfect and the vine is in fine condition.

Here I would remark that the leaves of all treated vines have been much less eaten by insects than the untreated, especially of those in vineyard where no treatment was given.

GENERAL CONCLUSIONS.

(1) All the preventive effect evident in my experiments seems to me certain to have come from the *earlier* treatments, especially with the Bordeaux mixture, and where it reached every part of the surface of fruit. This was well shown in clusters of Brighton once thoroughly treated with Bordeaux mixture, on May 27, allowed to ripen, and were then hung in a show-case, where I frequently hang fruits as samples and where ripe grapes usually rot in a week to ten days in July and August, Brighton especially, yet these Brighton clusters hung there about five weeks, *and all were yet sound.* So I concluded that if the Bordeaux mixture be sprayed thoroughly over the vines in spring before they leave out, and over the posts everywhere, also a spray over the ground, then again of weaker strength just before or as the vines bloom, and again when fruit is not over one-third grown, during cloudy weather or when dew is on, that benefit will most likely be the result. But it is a curious fact that Goethe never showed any signs of rot during the first attack, and yet everywhere, almost, showed rot during the second period, even where well sprayed each time and no matter what preparation, indicating varying effects on different varieties.

(2) Low, rich, and undrained or poorly drained land exerts a great influence favoring rot, while high, well-drained, gravelly or red clay lands are unfavorable to rot, as shown in many vineyards in this region.

(3) The most potent resistant to the black rot appears to reside in certain varieties and species having very firm, dense skins, whether thick or thin, and also probably in some acid or acrid element residing in the skin before ripening; and hence to plant more largely of such varieties

as Perkins, Ives, Delaware, Norton, etc., known to resist, and to bring up new varieties from these, and the Æstivalis, Riparia, Rupestris, and other species nearly always found resistive, promise the most certain escape from this destructive malady.

Date.	Temperature.		Wind.	Observations.
	A. M.*	P. M.*		
May 7	72	70	SW. a. m., SE. p. m	Clear; cloudy in NW. in the evening.
10	62	78	SE	Mostly clear; heavy rain evening of the 9th.
11	62	78	SE	Clear.
12	68	80	SE	Clear; lightning in NW. in the evening.
14	70	85	SE	Clear.
15	65	82	NW. a. m., SE. p. m	Heavy rains.
16	64	80	ESE. and NE	Cloudy; rain at night.
17	60	70	NE	Showery.
18	62	78	NE	Clear.
19	60	84	NE	Clear.
20	66	80	SE	Fair.
21	70	84	SE	Cloudy; shower at night.
22	72	92	SW. and SE	Clear.
23	70	93	N. then SE	Some clouds; rained in morning.
24	72	†95	SE	Cloudy and sultry; lightning in NE. last night.
25	75	101	SE	Cloudy.
26	70	100	SE	Cloudy and sultry.
27	70	80	NNE	Heavy rain in a. m. with hail.
28	66	80	NE	Cloudy.
29	70	90	NW. SE	Clear.
30	70	90	SW., NE., NW	Clear.
31	64	85	SE	Clear.
June 1	66	90	SE	Clear.
2	70	85	SE	Cloudy.
3	72	90	SE	Cloudy; rain.
4	74	92	SW., W., SW., and N.	Cloudy; heavy rain in a. m.
5	72	90	SE	Cloudy.
6	70	90	SE	Cloudy.
7	73	90	SE	Clear; sprinkle in a. m.
8	72	95	SE	Clear.
9	73	93	SE	Cloudy; local rains.
10	72	85	SE	Cloudy; local rains.
11	73	90	SE	Heaviest rain ever recorded in Dennison.
12	72	85	SE	Clear.
13	73	90	SE	Cloudy in a. m.; sprinkle; clear p. m.
14	68	90	SE	Clear.
15	70	90	SE	Clear; heavy dews.
16	72	92	SW	Clear; heavy dews.
17	72	96	SW	Clear; less dew.
18	73	95	SW	Clear; cloudy in NW.
19	73	98	SW	Cumulus high.
20	77	†103		Hazy; calm.
21	......	......		From this date to 25th range of temperature from 70° to 98°; wind generally SSW.
26	75	95	S. E	Cumulus clouds; heavy rain at 3 p. m.
27	......	......		From this date to July 11 range of temperature from 70° and 80° at 6 a. m. to 90° and 100° at 2 p. m., with much rain.
July 12	......	......		From this date to August 5, dry and hot.

* 6 a. m. and 9 p. m., unless otherwise stated. †2 p. m.

Respectfully,

T. V. MUNSON.

HON. NORMAN J. COLMAN,
Commissioner of Agriculture.

EXPERIMENTS AT NEOSHO, MISSOURI.

SIR: In accordance with your instructions, I have the honor to submit the following report of experiments conducted by me, under your direction, in the treatment of the diseases of the vine.

First, I will briefly reply to your series of questions relative to experimenting with remedies in the treatment of these diseases.

(1) The remedies employed were Bordeaux mixture, eau celeste, and sulphatine, prepared according to directions.

(2) The vines treated embraced over 100 varieties of Vitis, including every native species.

(3) The area covered was about 14 acres.

(4) The amount of material used was about 100 gallons Bordeaux mixture, 260 gallons eau celeste, 50 gallons simple solution, and 20 pounds sulphatine.

(5) The materials used cost about $38.

(6) The amount of time spent in preparing and applying the preparations was somewhere near twenty-six days' work of eight hours each.

(7) Four to six applications were made, commencing May 29 and repeating every month.

(8) The applications remained visible on foliage at least two months, inspite of heavy rains.

(9) The first appearance of the mildew was on May 30, on Delaware.

(10) The first appearance of the black-rot was on June 2, on Concord grapes, and May 20 to 24 on foliage.

(11) All grapes subject to rot were badly affected in 1885 and 1886. Mildew was very severe on Delaware and Elvira in 1886.

(12) At the date of the first application rot was just beginning on the foliage. Mildew appeared a few days later. The foliage of treated vines two weeks before the usual time for the falling of the leaves was perfect. On the untreated all the leaves were ruined by mildew.

(13) The condition of new wood as to ripening, etc., upon treated and untreated vines, was as marked as the differences which appeared in the foliage.

Our rain-fall during the month of August amounted to 8 inches; the rains were general, extending over quite a range of country, while the heavy storms and floods reported in June and July were quite local, so that a large part of Newton County suffered more or less from drought.

EXTRACTS FROM NOTE-BOOK.

May 29.*—Applied, with bellows, sulphatine to nursery rows of Elvira, Missouri Riesling, Grein's Golden, also to G. W. Campbell (Triumph Seedling).

June 1.—Prepared various remedies and applied on a few vines in vineyard and in nursery to observe effect on foliage. Drenched a young Elvira vine with eau celeste; no harm done.

June 2, 3, 4, 5.—Made vigorous applications of various remedies with the Vermorel sprayer on the whole of my old vineyard (except test rows) during heavy dews, light fogs, showers (on 4th). Applied Bordeaux mixture, and same compound with *more lime*, profusely to grapes against rot.

June 5.—Applied more Bordeaux mixture with broom to rotting varieties. Also made second application of eau celeste, especially to the clusters of grapes, with the spraying pump. At this time Elvira, Noah, Ives, Concord, Goethe, Huntingdon, Rupestris, etc., are about the size of peas. All except Rupestris showing some specks of rot and a few bunches of Concord being already one-third rotten. Norton, Æstivalis x Rupestris No. 70, and Elvira Seedling No. 100 at this date are through blooming, while Æstivalis (type Lincecumii) are in full bloom. Heavy application of Bordeaux mixture and eau celeste made on Lincecumii now in bloom. Anthracnose serious in lowest vineyard.

June 10.—Light shower in afternoon, after which I sprinkled, with a whisk, two rows of Cynthiana and Concord with simple solution (1 to 20), and four rows of Cynthiana and Racine with simple solution (2 to 20), all in old prairie vineyard.

June 11.—In the evening, after a rain, sprayed simple solution (2 to 20) a row of young vines and a row of old Rupestris, etc.; also on grafted vines in prairie vineyard, treated before with Bordeaux mixture.

June 12.—A leaf of Delaware, having three plain spots of mildew on 5th, when treated with eau celeste shows the same spots yet, but they have not increased in size and the leaf remains otherwise healthy and adheres well. It seems yet doubtful whether the sulphate of copper remedies will prevent black-rot, as it evidently does mildew. The second attack of rot must be terrible and will furnish the proof desired. Leaves of a Rupestris on south end of row in old prairie vineyard are scorched. This vine was treated on 10th to simple solution (1 pound to 20 gallons) while yet moist with rain, but during hot sunshine.

June 13.—Sprayed vines in summer-house with very weak simple solution; also part of vines in nursery with a solution $\frac{1}{4}$ pound to 20 gallons.

June 16.—A number of the vines sprayed with a whisk on 10th, after shower, but followed by short sunshine, show scalding.

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* Early spring, warm and dry. Heavy rain (3 inches) May 23, 24 and 25, followed by heat, fog, heavy dews, and showers.

June 17.—Second attack of rot. Terrible on Racine and on others in bloom, during first attack.

June 20.—Rot continues along the whole line; has already ruined over 50 per cent. of Concord and Racine; considerable, about 10 to 12 per cent., on Ives, Noah, Black Pearl, Ball's White, Norton, Hermann, Delaware, Goethe, Uhland, Grein's Golden and many more. Rot, to the amount of from 3 to 5 per cent., on Perkins, Jaeger's Nos. 100 and 70, Elvira, Missouri Riesling, Neosho, and Lady. Little or no rot on Norton (syn. Cynthiana), Huntingdon, Lincecumii No. 42, Linceo x Rupestris (new). No rot at all on Lincecumii Nos. 43 and 13, and all Rupestris.

June 21.—Careful comparison of treated vines with those not treated shows no difference in respect to rot. Herbemont and Lincecumii No. 50 rots badly. Some rot also on No. 55, which never rotted before. While the sulphate of copper compounds prove of little or no value against black-rot in grapes, they do seem to prevent anthracnose as well as mildew, if applied in time.

June 24.—Two rains and several showers, amounting in all to about 1½ inches of water. The night following and on June 25, 3 inches of rain fall.

June 26.—In the evening applied sulphatine to seedlings of *Vitis Novo-Mexicana*, *V. Monticola*, *V. Koshui* and *V. ficifolia* (the last two Japan varieties), and all other vines from seed of this spring's planting.

June 27.—A new and severe attack of mildew on Delaware vines in old vineyards, confined entirely, however, to leaves of recent growth. Has not increased on the foliage which was treated about June 1. Also find many fresh spots of mildew on many Lincecumii, Elvira, and others. After all these rains the Bordeaux mixture is still plainly visible. Eau celeste appears to have more immediate effect, while the beneficial qualities of Bordeaux mixture seem more lasting. In evening and night applied eau céleste (new formula, 40 gallons water, 2 pounds sulphate of copper, 3½ pints ammonia) to Delaware vines (all except test) and to all Elvira except test rows, and to a number of other varieties in nursery.

June 28.—Continued the application of eau celeste to old vineyard on hillside.

June 30.—Applied the Bordeaux mixture (new formula, 22 gallons water, 6 pounds sulphate of copper, 2 pounds lime) to all parts of various vineyards formerly treated by Bordeaux mixture (old receipt). Again treated all the fruit with a heavy spraying. Find black-rot still increasing.

July 1 and 2.—Applied eau celeste, new formula, to all portions of various vineyards formerly treated by eau celeste, old formula; also paying special attention to spraying of fruit.

July 4.—Treated with simple solutions (1 pound to 20 gallons and 2 pounds to 20 gallons) vines formerly thus treated.

July 5.—Treated with eau celeste the whole nursery. *Novo-Mexicana, Monticola, N.-Mex.* x No. 70, seedlings all very subject to mildew. Still more so are the Japan grapes, none of which would survive but for copper applications.

July 8.—Treated with sulphatine all vines formerly thus treated.

July 11, 12, 13.—Sprayed with eau celeste all my young vineyard planted last winter (about 8 acres).

July 14.—Examined all the various vineyards and find again no difference between treated and untreated vines in regard to black-rot. Black-rot (*Physalospora Bidwellii*) has by this time ruined the entire crop of Concord, Racine, Martha, Uhland, the various Vinifera x Labrusca hybrids, and most pure Labruscas. About one-half of the fruit of Delaware, Noah, Black Pearl, Grein's Golden, Etta, and Hermann is now ruined by black-rot. On Elvira, Ives, Perkins, Missouri Riesling No. 70, Elvira Seedling No. 100, rot has not increased since June 20. Norton (syn. Cynthiana) and Huntingdon show only an occasional rotten berry, while Lincecumii No. 43 and 13 and all Rupestris remain entirely free from rot.

July 15.—Examinations as to mildew (*Peronospora*) as well as anthracnose (*Sphaceloma ampelinum*) made in all parts of vineyards treated as well as in other vineyards of the neighborhood not treated. Mildew has attacked severely all Elviras and especially all Delawares not treated. Many leaves already burnt or fallen off on those varieties; also some on Clinton, Black Pearl, and Uhland. Some varieties treated show no mildew except the slight attack they had before first treatment (end of May). Treated rows of Delaware and Elvira show a decided brighter, greener, and healthier color than those not treated. On other varieties no difference is visible except on close observation. Occasional spots of mildew are found on all varieties (Norton not excepted) where not treated with sulphate of copper, while on rows thus treated no mildew can be found. By the end of August, doubtless, a superficial observation will suffice to distinguish rows untreated from the treated parts of the vineyard. Sulphate of copper seems to be quite as effective against anthracnose as against mildew. Lincecumii No. 43, a variety very liable to anthracnose, especially shows beneficial effect of treatment.

In two cases the foilage was injured (burnt) by the preparations of sulphate of copper. First, by application of simple solution (2 pounds to 20 gallons, and 1 pound to 20 gallons) made late in afternoon following a shower, but during a short period of sunshine. No injury from same application made after sundown. Second, by the heavy application of sulphatine made on July 8, the foliage scorching and dropping during succeeding days of hot sunshine. Other vines similarly treated but not so directly exposed to the sun were not injured. Many experiments made on a small scale have convinced me that it is sunshine during or soon following an application of copper solution that must be avoided. Even tiny plants fairly drenched with strong solutions during cloudy weather or after sundown have not suffered at all, while quite weak solutions scald the foliage whenever applied in sunshine. Sulphatine in all cases ought to be used sparingly; a mere light dusting, but no thick covering of leaves.

My practice now is to spray during cloudy weather only, when there is no danger of sun soon bursting through the clouds. My favorite time for operating is after sundown and as long as I can see. To this when there is much work on hand I add moonlight nights. No vine thus treated will ever be scorched by the applications.

Examination of other (untreated) vineyards in my neighborhood shows a general invasion of mildew, but no serious damage up to date, except on Delaware, Elvira, Prentiss, Niagara, and other Vinifera hybrids. Have also found Peronospora on wild vines of Cardifolia and Æstivalis species. Examination of nursery shows young plants of Koshui and Ficifolia (Japan grapes grown from seed) are exceedingly subject to mildew. A few grow quite vigorously and much resemble our Lincecumii; but repeated applications of eau celeste alone preserve young leaves from being mildewed as fast as they appear. On some other varieties in nursery it is also advisable to make an application about every second week, since the constantly forming young leaves are liable to mildew.

July 20.—Tornado, hail, and flood.

July 21.—Yesterday's storm was the worst experienced here in twenty-two years. Fences and trellises blown down; also many fruit and forest trees. All bunches of grapes spoiled for market and only about one-third of berries left fit for wine. Foliage of vines and everything else beaten off or lacerated by hail. Damage to growing crop $6,700, and wood for the year badly injured.

Towards the end of August one more general application of eau celeste (new formula) was made; I confined myself to eau celeste this time because I found its effect fully as beneficial and lasting as that of Bordeaux mixture, while it is cheaper and more easily prepared and applied.

During September the rain amounted to 7.3 inches and was again of a general nature. Made one more application of eau celeste to Elvira and Delaware vines in my old vineyard and to all of the new plantation and nursery. In October gave another spraying with eau celeste, this time only to nursery vines.

October 1 *to* 11.—We had 6.2 inches of rain, and on October 12, white frost sufficient to kill the foliage of all vines in my own vineyard excepting the species of Rupestris, Riparia, and Novo-Mexicana, and their hybrids.

My new vineyard and the nursery vines, being situated higher, were not affected by this first frost, and the foliage kept green and healthy until October 30, when a hard frost killed all the leaves.

The invasion of mildew during August and September in the vineyards of southwestern Missouri was beyond question the heaviest and most general which we have noticed during twenty-two years of residence here. Varieties like Delaware, Elvira, Uhland, and all Vinifera hybrids have had their foliage injured by mildew repeatedly, but never before this season have I seen such vines as Ives, Concord, and Norton or Cynthiana prematurely defoliated by this fungus.

It is no exaggeration to say that from the latter part of September to October 30 the vines treated by sulphate of copper remedies were the only ones retaining a green and healthy foliage, and presented a striking contrast to the denuded vines not thus treated.

This contrast spoke all the louder in favor of blue-stone applications, when it is considered that these green vines were stripped of foliage by a hailstorm of July 20, and had to make this fresh and healthy growth during a most intense and general invasion of mildew. The fact that, in spite of such a combination of adversities, I now have a fair growth of well-ripened wood, is no doubt due entirely to the application of these remedies.

Therefore I am determined to repeat these experiments next season, and to make the first application of eau celeste as soon as foliage appears, and before even the earliest blooming species have opened their flowers. By so doing, and by repeating this treatment at intervals, being guided mainly by weather prevailing, I now feel confident we need have no further fear of either mildew or anthracnose.

As to black-rot (*Physalospora Bidwellii*), I will only add that, while so far results were not encouraging, yet I still have some hope that as a *preventive* the sulphate of copper solutions may yet prove useful. I was not aware until the present season, and then too late to take advantage of the fact, that the spores of *Physalospora*, or black rot, attack the foliage as well as the fruit of vines. I am indebted to that eminent authority in viticulture, Prof. Pierre Viala, of Montpellier (France), who has honored me with a visit this fall, for calling my attention the reddish-brown spots caused by black-rot fungus on vine leaves, and I well remember that those same spots were abundant on the foliage of many vines at least ten days before the first spraying.

It is evident, therefore, that the remedies were applied after the invasion of the disease. The white-rot of grapes (*Coniothyrium diplodiella*) was discovered here, during the visit of Professor Viala, on vines of the Labrusca, Æstivalis, and Riparia species, in a few cases so abundant as to destroy one-fifth of the berries on a bunch. This, in a vineyard adjoining mine, and in same soil and situation, while in my own vineyard, sprayed with blue-stone solutions, very few berries could be found attacked by this special form of rot.

The above-mentioned observations certainly justify the hope that very early and repeated sprayings may yet prove useful in combating both black-rot and white-rot.

Record of temperature, rainfall, dew, etc., from June 5 to October 25.

Date.	Temperature.			Rain.	Dew.	Fog.
	6 a.m.	1 p.m.	6 p.m.			
1887.						
June 5	55	93	83		Very heavy	Some.
6	58	92	83		Heavy	
7	70	90	84		Medium	
8	72	90	85		do	
9	73	92	84	2 showers, 0.1 inch	do	
10	70	94	83	2 showers, 0.2 inch	Heavy	
11	73	80	78	2 showers, 0.4 inch	do	
12	75	97	75	1 rain, 1 inch	do	Some.
13	74	88	83		do	Trace.
14	62	90	84		do	
15	64	90	85		do	
16	66	89	85		do	
17	70	92	86		Light	
18	68	96	93		Heavy	
19	76	96	94		Medium	
20	74	97	92		Light	
21	62	85	83	1 rain, 0.1 inch	do	
22	64	82	80		Heavy	
23	62	82	79		do	
24	62	78	75	Several, 1.4 inches		
25	64	78	76	All night, 3 inches		
26	70	88	82		Heavy	
27	68	84	80		do	
28	70	88	72	Sprinkle,		
29	73	81	80	Sprinkle, 0.3 inch	do	
30	70	80	78	Sprinkle,		
July 1	72	80	76	Several, 0.5 inch	do	
2	70	82	80	1 sprinkle	do	
3	72	89	88		do	
4	75	92	78	2 rains, 0.2 inch	do	
5	78	94	72	2 rains, 2 inches	do	
6	72	88	86	2 rains, 0.2 inch		Heavy.
7	68	94	89			Light.
8	68	92	88		Heavy	
9	69	87	86		do	
10	76	92	91		do	
11	80	95	93		do	
12	80	95	94		do	
13	81	95	90		do	
14	76	95	92		do	
15	78	94	80	1 rain, 0.2 inch	do	
16	75	92	89		do	
17	79	93	90		Light	
18	80	95	92		Heavy	
19	74	92	91	1 rain, 0.1 inch	do	
20	79	94	67	3.5 inches.	do	
21	64	86	75	1 rain, 0.5 inches	do	
22	66	89	87		do	
23	75	90	90		do	
24	77	92	91		do	
25	78	90	89		do	
26	70	92	91		do	
27	74	93	92		do	
28	73	94	93		do	
29	78	97	96		do	
30	82	100	98		do	
31	76	96	78	1 rain-storm, 1.7 inches	do	
Aug. 1	76	92	80		do	
2	70	94	92		do	
3	78	95	93		do	
4	80	96	95		do	
5	78	93	92		do	
6	76	90	88		Medium	
7	79	92	91		do	
8	80	92	90		do	
9	80	93	91		do	
10	78	92	91		do	
11	79	96	94	1 rain, 1 inch	do	
12	76	90	93		Heavy	
13	83	94	88		do	
14	82	94	96	1 rain, 0.3 inch	do	
15	70	83	82	1 rain, 0.2 inch	do	
16	72	78	81	3 rains, 0.3 inch	do	
17	70	82	80		do	
18	71	85	83		do	
19	70	88	86	1 rain	do	

Record of temperature, rainfall, dew, etc., from June 5 *to October* 25—Continued.

Date.	Temperature.			Rain.	Dew.	Fog.
	6 a.m.	1 p.m.	6 p.m.			
1887.						
Aug. 20	69	90	88		Heavy	Light.
21	72	91	78	1 sprinkle	Medium	
22	66	80	79	All night, 4 inches	Rain	Light.
23	58	65	62		Heavy	
24	56	64	63		do	
25	60	61	59	All day, 1.3 inches	do	Light.
26	57	68	64		do	Medium.
27	54	82	76		do	
28	60	78	72		do	Light.
29	64	72	70		do	Heavy.
30	64	71	70	Rains, 0.7 inch	Rain	
31	68	86	78		Heavy	
Sept. 1	64	85	79		do	
2	66	87	79		do	
3	68	88	82	Many sprinkles, 0.2 inch	do	
4	72	90	87	1.2 inches	Rain	
5	70	84	78		Heavy	Light.
6	71	89	83		do	
7	70	89	84	Sprinkle	do	
8	71	93	87		do	
9	72	92	85		do	
10	72	92	83	1 rain, 1.1 inches	do	
11	70	88	86	2 rains, 0.3 inch	Rain	
12	74	92	88		Light	
13	75	80	67		do	
14	60	76	64		do	
15	62	80	68		Medium	
16	60	71	61	Showers, 0.4 inch	Heavy	
17	59	69	66	Rains, 0.8 inch	Rain	
18	69	80	78		Heavy	
19	70	80	72		do	
20	69	88	74		do	
21	71	83	65	Rain, 1.1 inches	do	
22	68	83	75		do	
23	51	66	58	Sprinkles	do	
24	48	65	63		do	
25	58	73	68	Rain, 1 inch	Rain	Misty.
26	62	68	63	Rain, 0.3 inch	do	Do.
27	57	66	64	Rain, 0.4 inch	do	Do.
28	60	69	68	Rain, 0.2 inch	do	Do.
29	50	64	61	Rain, 0.3 inch	do	Do.
30	56	76	72		Heavy	Heavy.
Oct. 1	60	79	75		do	
2	57	78	71	Rain, 0.1 inch	do	
3	55	77	71		do	
4	52	80	75		do	
5	61	83	76		do	
6	66	84	77		do	
7	70	76	68	1 rain, 0.6 inch	do	
8	65	75	63	Rain, 2.1 inches	Rain	
9	62	60	58	Rain, 1.3 inches	do	
10	56	64	52	Rain, 2.1 inches	do	
11	49	54	45		Heavy	
12	31	62	52		Frost	
13	38	75	60		Heavy	
14	40	71	56		do	
15	41	74	65		do	
16	49	77	67		do	
17	51	72	63		do	
18	46	62	55		do	
19	36	70	61		do	
20	45	74	65		do	
21	52	80	75		do	
22	54	81	74		do	
23	50	75	70		do	
24	42	61	58		do	
25	38	59	56		Medium	

Respectfully,

HERMANN JAEGER.

HON. NORMAN J. COLMAN,
Commissioner of Agriculture.

PART II.

VOLUNTEER REPORTS ON THE TREATMENT OF THE DOWNY MILDEW AND BLACK-ROT IN 1887.

VOLUNTEER REPORTS OF CORRESPONDENTS.

INTRODUCTORY.

Early last spring (1887) the following circular was widely distributed throughout the grape-growing sections of the country:

[Section of vegetable pathology.—Circular No. 3.]

U. S. Department of Agriculture,

Botanical Division.

TREATMENT OF THE DOWNY MILDEW AND BLACK-ROT OF THE GRAPE.

To the Vineyardists of the Country:

Last year a circular was sent out by this Department recommending for trial certain remedies for the mildew and rot of the grape.

The results of experiments in 1886 have fully demonstrated the value of sulphate of copper, "blue-stone," over all other remedies in combating the mildew, and the results of many chemical analyses of the fruit and parts of vines treated with the copper compounds have clearly shown that there is no danger to health attending their application. The only precaution advised is not to apply them near (within fifteen days of) the vintage.

In their employment the fact must be kept in mind that their action is only preventive, therefore their application should be made early in the season, from the latter part of May to the end of June. Subsequent applications act only in so far as they serve to check the spread of the disease. The amount of the fluid compounds required to treat an acre of vines will depend largely upon the kind of pump and spraying nozzle used to apply them, and upon the extent of growth of the vines themselves; the amount may vary from 20 to 35 gallons.

The following are the formulæ of the remedies which so far have given the best results. An account of the results of trials you may make with one or more of them is earnestly desired, and a blank form for making up a report for the use of the Department in future publications will be sent you upon the receipt of the addressed postal card inclosed herewith.

LIQUID REMEDIES.

(1) *Simple solution of sulphate of copper.*—Dissolve 1 pound of pure sulphate of copper in 25 gallons of water. Spray the vines with a convenient force-pump having a nozzle of fine aperture. Less lasting in its effect than the next, as it is easily washed off by rains.

(2) *Eau celeste, blue water* (the "Audoynaud process").—Dissolve 1 pound of sulphate of copper in 3 or 4 gallons of warm water; when completely dissolved and the water has cooled, add 1 pint of commercial ammonia; then dilute to 22 gallons. The concentrated liquid should be kept in a keg or some wooden vessel and diluted when required for use. Apply the same as in the case of simple solutions.

The effects obtained by this preparation have been equal to those resulting from the use of the copper mixture of Gironde, and are said to be even more lasting.

(3) *Copper mixture of Gironde, Bordeaux mixture.*—Dissolve 16 pounds of sulphate of copper in 22 gallons of water; in another vessel slake 30 pounds of lime in 6 gallons of water. When the latter mixture has cooled, it is slowly poured into the copper solution, care being taken to mix the fluids thoroughly by constant stirring. It is well to have this compound prepared some days before it is required for use. It should be well stirred before applying. Some have reduced the ingredients to 2 pounds of sulphate of copper and 2 pounds of lime to 22 gallons of water, and have obtained good results.

Well-made pumps with specially constructed nozzles are required for the application of this compound, unless we resort to the tedious and wasteful method of using brooms or wisps made of slender twigs, which are dipped into the compound and then switched right and left so as to spray the foliage, as directed in our circular of last season. The Vermorel apparatus, including reservoir, pump, and spraying nozzle, is well adapted for vineyard use, and is specially constructed for applying the various liquid preparations containing sulphate of copper.

POWDERS.

(4) *David's Powder.*—Dissolve 4 pounds of sulphate of copper in the least possible amount of hot water, and slake 16 pounds of lime with the smallest quantity of water required. When the copper solution and the slaked lime are completely cooled, mix them together thoroughly, let the compound dry in the sun, crush and sift. Apply with a sulphuring bellows furnished with an outside receptacle for the powder. The copper coming in contact with the leather will soon destroy it.

(5) *Sulphatine.*—Mix 2½ pounds of anhydrous sulphate of copper with 15 pounds of triturated sulphur and 10 pounds of air-slaked lime. Apply in the same manner as No. 4.

Both these powders (Nos. 4 and 5) ought to be procured from the manufacturers prepared ready for use.

NOTE.—It is very probable that Nos. 2, 3, 4, and 5 will be found equally serviceable in preventing potato "blight" and "rot." No. 5 should be employed when one has to contend with both the downy and powdery mildews. For apple scab we suggest trials with Nos. 2 and 3.

The degree of success attending the use of these compounds will depend more or less (1) upon their careful preparation; (2) the time of application; (3) the more or less intelligent manner in which they are applied; (4) the atmospheric conditions existing at the time or which may follow the applications; (5) the number of treatments made; and (6) the purity of the copper used.

In all cases where these remedies are tried a number of plants or vines should be left untreated to serve as "control experiments," for comparison with those treated.

Prices of materials (subject, of course, to variations):*

	Per pound.
Sulphate of copper, pure, in quantity by the barrel	$0. 05 to $0. 06
At retail	10
Anhydrous sulphate of copper	28
Flowers of sulphur, wholesale	02½
Retail	.05 to .06

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* *Quotations made by a Philadelphia firm, February* 7, 1888.—Flowers of sulphur, in barrels, 3 cents per pound, retail 4 cents; powdered sulphur, in barrels, 3 cents per pound, retail 4 cents; liver of sulphur, wholesale 18½ cents, retail 25 cents; liquid ammonia, carboys at 7½ cents, retail 20 cents; carbonate of soda, cask 2 cents, retail 4 cents; carbonate of copper 62½ cents per pound; sulphate of copper, pure, in crystals, 7 cents per pound; sulphate of copper, anhydrous, 45 cents per pound; David's powder in barrels (200 pounds), $12.50 per barrel, 10 cents per pound; sulphatine in barrels (200 pounds), $16, per pound 20 cents.

	Per pound.
Ammonia, wholesale	$0.05 to $0.06
Retail	10
Lime, per barrel (200 pounds)	1.05
"Sulphatine," in quantity	.05 to .06

NORMAN J. COLMAN,
Commissioner of Agriculture.

WASHINGTON, D. C., *April*, 1887.

In order to secure as full reports as possible, the following printed letter was addressed to those who expressed the intention of trying one or more of the remedies enumerated in the above circular and making a report on the subject:

UNITED STATES DEPARTMENT OF AGRICULTURE,
DIVISION OF BOTANY, SECTION OF VEGETABLE PATHOLOGY.

The following series of questions will serve to suggest the chief points to be noted in experimenting with remedies for the fungus diseases of plants, and is prepared with especial reference to the treatment of the diseases of the vine.

In making the returns which you have kindly promised, you will greatly facilitate the work of the compiler, and at the same time give additional value and importance to your report, which will be published in a future bulletin, by noting the questions in the order given, replying to them as fully as possible.

Such documents or seeds as this Department may have to distribute will be sent you in return, upon application.

1. The kind of remedy or remedies employed, and how prepared.
2. Variety of vines or other plants treated.
3. Number of vines or area covered.
4. Amount of material used and how applied.
5. Cost of materials used.
6. Cost of labor in preparing and applying the same.
7. Number of applications made and date of each.
8. Date of first appearance of the mildew.
9. Date of first appearance of the black-rot.
10. Condition of vineyard in respect to disease in 1885–'86.
11. Condition of vines in respect to disease at time of first application, second application, etc.
12. Condition of weather at time of making the applications, and the kind of weather immediately following.
13. Condition of foliage at the vintage of treated vines compared with those not treated.
14. Condition of foliage two weeks before the usual time for the falling of the leaves on treated vines compared with those untreated.
15. Condition of new wood as to ripening, etc., upon treated and untreated vines.

NOTE.—When practicable, daily records should be kept of temperature, rain-fall, amount of dew, fogs, etc., for development of fungi is largely subject to existing meteorological conditions.

NORMAN J. COLMAN,
Commissioner of Agriculture.

MAY, 1887.

There was a very generous response to the request contained in the above circular, nearly two hundred reports being received, coming from thirty different States, showing clearly the interest felt in the matter and affording much valuable information. The substance of these reports is embodied in the following pages, and while it has been impossible to reproduce here in full all the reports, enough is presented to illustrate the extent and importance of the work, and coming, as it does, directly from the grape-growers themselves, will possess a special interest to those engaged in this pursuit.

It is often difficult to account for the diversity of results obtained by apparently the same treatment; they show, however, the necessity of continuing the experiments through a number of seasons before really definite conclusions can be reached. Little success appears to have been obtained in controlling the black-rot with the remedies employed. However, where this disease occurred it had, in nearly every instance, already become manifest either upon the fruit or foliage, before the applications were begun, and it is possible that earlier treatments might have led to better results. On the leaves black-rot appears in reddish brown spots (described on page 40 and illustrated on Plate VII, Figs. *c*, *d*, *e*, in Bulletin No. 2 of Botanical Division), and as these spots usually develop some days or even a week or two before the berries are attacked, one is warned of the presence of the disease in season to take measures for the protection of the latter. In very wet seasons the treatments ought to be made every fifteen days, and with the improved spraying pumps now manufactured such a course of treatment is practical, even in large vineyards.

In the hands of eight of the twenty-eight who experimented with the simple solution of sulphate of copper, the solution injured the foliage more or less seriously; and five of the fourteen who employed eau celeste met with similar results. There were twenty who claimed that the treatments were more or less valuable in checking the black-rot.

Because of injurious effects which have frequently followed the use of the simple solution of sulphate of copper and its lack of adhesion to the leaves, rendering frequent applications necessary, its employment during the vegetative period can not longer be advised. It is asserted, however, that both the simple solution and eau celeste may be used without fear of results in the latter part of the season after the leaves have acquired a certain firmness of growth.

In order to avoid the disastrous results which have, in the hands of some, followed the use of eau celeste, a certain amount of carbonate of soda is added and the solution prepared as follows: In two gallons of hot water dissolve two pounds of sulphate of copper; in another vessel dissolve 2½ pounds of ordinary carbonate of soda; then mix the two solutions, and when all reaction has ceased add 1½ pints of liquid ammonia, and then dilute with water to make 22 gallons.

Prepared in the same manner, the following formula may be substituted:

Sulphate of copper	pounds	6½
Carbonate of soda	do	7½
Ammonia	pints	1¾
Water	gallons	44

This compound is easily sprayed through any good nozzle; it leaves visible traces on the foliage to which it is strongly adherent, and it is claimed that it will not burn or injure the leaves in any stage of growth. The author of this preparation, Dr. Partrigeon* has named it the "Berrichonne mixture."†

Ammoniacal carbonate of copper solution, recommended by M. G. Gastine‡ is simple in preparation and comparatively inexpensive, and if it proves as efficacious as the Bordeaux mixture or eau celeste it will doubtless come into general use. It is prepared as follows:

In 1¾ pints of ammonia dissolve 2 ounces (or 2½ ounces) of carbonate of copper. This solution may be kept in a glass bottle and diluted with water, when required for use, to 22 gallons.

This preparation is said to be perfectly harmless to the foliage and is even more strongly adherent than eau celeste.

In regard to the Bordeaux mixture, it has been found that when the amount of sulphate of copper contained in it is less than 6–8 per cent., its efficacy is materially diminished.

The old formula (water 22 gallons, sulphate of copper 13 pounds, lime 26 pounds) is the one still held to be the best. The "new formula," or "mixture for general application," consists of:

Water	gallons	22
Sulphate of copper	pounds	6
Lime	do	2

Good results have been obtained with this mixture, but it is advisable, owing to the often impure character of the lime obtainable, to increase the proportion of this substance.

As to powders,sulphatine appears to be the best, all things considered. In districts where there are frequent dews this powder is highly recommended.

ALABAMA.

From this State two reports were received.

Mr. W. Q. Sewell, of Trinity, Morgan County, made one application of the simple solution of sulphate of copper to three hundred and forty vines, mostly Concords, using 25 gallons of the solution. Total cost, $2.50. There was no mildew, and owing to the continued dry weather there was very little rot on any of the grapes, treated or untreated. The

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*[*] *Progrès Agricole et Viticole*, July 3, 1887, p. 20.

[†] The practical value of these preparations containing carbonate of soda has yet to be determined by experiments.

[‡] *Progrès Agricole et Viticole*, August 7, 1887.

condition of the foliage on the treated vines, two weeks previous to the usual falling of the leaves, was far superior to that on those untreated, and the new wood showed a marked development of ripeness in favor of the treated vines.

The seasons of 1885 and 1886 were very wet, and both years the crop was almost a total failure because of rot.

From the published descriptions of white- and bitter-rots, Mr. Sewell concludes that it is these forms of rot, and not the black-rot, which have affected his grapes—the white-rot on the higher grounds and the bitter-rot in the basins or wetter portions of his vineyard. His grapes were attacked just before they began to ripen, and the affected berries fell off at the slightest touch or even by their own weight, so that by the end of the vintage the ground was covered with the rotting fruit. This disease is worse in wet seasons than in dry, and the wetter the season the worse the disease. Acknowledging Mr. Sewell's report and in reply to some remarks in it, the following letter was addressed to him:

* * * That the parasites, which by their growth in the tissues of the grape berries produce the several forms of rot, did so little damage to your crop of 1887 is doubtless attributable, as you say, to the dry weather prevailing during the grape season. It is well known that these parasites require for their development a considerable amount of moisture, and hence it is only in seasons of frequent rains and heavy dews that they are able to occasion serious injury; in such seasons we can only hope to ward off their attacks by adopting suitable preventive measures. The plan you propose of destroying or burying in the fall or winter the débris accumulated during the season of growth, may assist in the mitigation of the losses arising from the grape rot by destroying vast numbers of the spores or seeds of the parasites which cause the disease, but this practice alone will not entirely remedy the evil, as has frequently been proved by experiment.

Other measures must be adopted in order to secure success. The bagging process seems as yet to be the only certain preventive of the disease, but, unfortunately, this is only practicable in vineyards of small extent. In all cases, however, where bags have been placed over the bunches before the fungi had had time to come upon the forming berries, they have escaped the rot. It is yet doubtful as to the effect of the sulphate of copper compounds upon this disease. The testimony so far received is conflicting, but the bulk of the evidence is to the effect that they are of no value. Further trials are necessary to settle this question.

The different forms of rot—black-rot, white-rot, bitter-rot—are caused by fungi, each form being produced by a special fungus, quite distinct from those under whose action the other forms appear. These fungi are plants like the vines themselves, differing from the latter only in their minute size and in their habits of growth, and there is a much greater difference between the fungus which produces the black-rot and the fungus which causes bitter-rot than there is between the most widely different grape-vines which you cultivate. Their effects upon the berries which they attack are markedly distinct, as I have at various times attempted to point out.

If you will send me some of the berries destroyed by rot the past season (you may yet find them upon the ground under the vines) I may possibly be able to determine the form of rot—black, bitter, or white—which attacked them. With the aid of the microscope it will not be difficult to determine.

I am especially interested in your statement of the effect of the application you made of the simple solution of sulphate of copper, for it differs from that of many who employed it. In many cases it has scorched or burned the foliage, sometimes so severely as to cause the premature fall of the leaves. You say, however, that the foliage of your treated vines is in much better condition than that of those untreated, and that at two weeks previous to the usual time of the falling of the leaves, the foliage on the treated vines was far superior to that of the untreated, and later the evidences of the ripening of the wood was decidedly in favor of the treated vines.

It is necessary for me to obtain a knowledge of a number of facts or circumstances connected with the subject, impossible to acquire now, in order to explain these differences in results.

Respectfully,

NORMAN J. COLMAN,
Commissioner of Agriculture.

Mr. Thomas Brigden, of South Lowell, Walker County, applied the simple solution of sulphate of copper (2 pounds copper sulphate to 45 gallons of water), with a small broom, to about three hundred vines, chiefly Concords, on May 20, 30, and June 9.

In 1885 there was but little mildew or rot. In 1886 some vines mildewed badly and fully two-thirds of the crop was destroyed by rot.

At the date of the first application about one-third of the leaves were spotted with mildew. The solution applied appeared to stop its spreading, but in ten days the new growth became infected and a second application was made. This was followed by the same results as the first made, and on the 9th of June the vines were treated for the third and last time.

The vines treated gave fully a half crop, of fair quality; those not treated shed their leaves early and produced no fruit. During the season, until the grapes began to color, the weather was extremely wet and hot.

ARIZONA.

One report was received from Mr. G. W. F. Johnson, of Phœnix, which was to the effect that the vineyards in Arizona were perfectly healthy, needing no treatments for disease of any kind. One vineyard of 640 acres was planted this season and is doing finely.

ARKANSAS.

Five reports were received from Arkansas, from the following-named parties:

Dr. A. Belcher, Benton County; John M. Clayton, Elk Horn, Benton County; D. D. Forman, Hacket, Sebastian County; L. Graf, Van Buren, Crawford County; Emile Westermann, Malvern, Hot Springs County.

Dr. Belcher applied the simple solution (remedy No. 1, circular 3) to a few vines once a week during the month of June. The foliage kept in perfect health, but the grapes rotted badly, very few ripening.

Mr. Forman applied the Bordeaux mixture three times, June 5, 7, and 18, to 4 acres of vines, consisting of Concords, Clintons, and Delawares. One hundred pounds of sulphate of copper were used and one barrel of lime, part of the former being applied alone in solution. The applications were made with brooms. Cost of sulphate of copper, $9; lime, $3; labor of preparing and applying, $9; total cost, $21.

Black-rot appeared on June 3 or 4, and ravaged the vineyard unchecked by the remedy employed. The season was unusually rainy, with heavy fogs and dews.

Mr. L. Graf experimented with eau celeste on a few vines, making three applications, June 8, 12, and 28. The grapes had already made a considerable advance in rotting before the first treatment, this disease, together with the mildew, having appeared about May 10, and no benefit resulted from the applications.

Mr. Graf proposes to make a more extended trial next year, beginning earlier in the season.

Mr. Emile Westermann applied a simple solution of sulphate of copper (3 pounds to 25 gallons of water), sprinkling the vines all over, with brooms made of twigs, on May 15, June 1, and June 15. This treatment was successful in combating the mildew. The treated vines held their foliage long after the untreated ones, and their wood ripened better. Mr. Westermann says: "I have specially experimented with Champion, Ives, and Delawares, treating 4 rows and then leaving 4, and so on over about 10 acres."

The mildew (Peronospora) appeared June 15, and the black-rot five days earlier. The latter disease appeared after a warm, heavy rain, and within ten days totally destroyed the fruit of Herbermonts, Neoshos, Black July, and Hermann, and three-fifths of Ives, Martha, and Delaware, leaving uninjured Norton, Elvira, and Louisiana. The remedies tried for black-rot gave no satisfactory results. It has usually happened that from the 1st of June to about the 25th there have been a series of heavy rains, inducing the development of the fungus parasites; after this period the weather usually changes and rot disappears.

CALIFORNIA.

Nine reports were received from California, but as there is no black-rot in that State and as the mildew referred to in some of the returns was certainly the "oïdium," or powdery mildew, it seems unnecessary to detail the experiments made.

Through correspondence with California grape-growers in 1886, the Department was led to believe that the downy mildew was a serious pest in a number of counties of the State, but personal observations made during the past season (1887) in the districts thus supposed to be most affected failed to discover any traces of the parasite. The powdery mildew was frequently observed and a few grape leaves affected with "erinose," which might be mistaken for the downy mildew by the uninitiated, were discovered, but no evidence of the presence of the downy mildew itself was seen. There is good authority* for saying, however, that this fungus does occur within the State, and certainly all grape, growers should take pains to learn to recognize it in order to detect at once its presence on their vines should it ever attack them, that they may immediately proceed to combat it.

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* Dr. W. H. Harkness, in Bulletin No. 7 of the California Academy of Sciences, June, 1887.

Mr. L. C. Gage, of Lincoln, Placer County, the only gentleman who positively reports the presence of the downy mildew in 1887, applied the simple solution of sulphate of copper (1 pound to 25 gallons of water) to a 12-acre vineyard of Zinfandels and Muscats, making the applications from June 12th to the 18th. This year the downy mildew, Mr. G. states, appeared May 29. In 1886 nearly the whole vineyard was overspread with the disease and a great many vines lost their leaves in August. After the treatment this season no further effects of downy mildew were noticed. It does not appear that the simple solution injured the foliage, so frequently reported to be the result of its use in the Eastern States.

CONNECTICUT.

The entire absence of black-rot and the little or no development of the mildew during the past season rendered the application of remedies unnecessary. The mildew was very severe about Woodstock in 1886, but in 1887 the vines were free from the disease, although the weather throughout the season was very moist. Reports were received from—

Geo. S. Butler, Cromwell, Middlesex County; G. A. Bowen, Woodstock, Windham County; P. M. Augur, Middlefield, Middlesex County; Whitney Elliott, North Haven, New Haven County; S. R. Gridley, Bristol, Hartford County.

Mr. Augur made one application of the simple solution (11 pounds sulphate of copper to 25 gallons water) to 60 vines of Lindleys. The leaves were burned by the application, resulting in their falling prematurely.

DAKOTA.

Only one report, from S. H. Meecher, who states that the Concord, Janesville, and other so-called hardy grapes were winter-killed the past three seasons, although covered with 4 to 6 inches of earth. He made no experiments.

FLORIDA.

The only party reporting from this State, Mr. William A. Marsh, of Orlando, Orange County, writes that he noticed the appearance of the downy mildew May 15. Made one application of eau celeste June 14. There had been a heavy rain just previous to the application. The weather following was dry. The season was a comparatively dry one. There was no black-rot. The condition of the foliage on the treated vines was good at the vintage, but that of the untreated vines was cut full of holes by the "leaf-roller." The vines treated were entirely free from the ravages of this pest.

GEORGIA.

Those reporting from this State are:

W. W. Thompson, Smithville, Lee County; W. J. Goss, Harmony Grove, Jackson County; Gugie Bourquin, Savannah, Chatham County; J. G. Justice, Marcus, Jackson County; James Sneed, Morrow Station, Clayton County; J. D. Husted, Vineyard, Spalding County.

Mr. Thompson experimented with eau celeste and Bordeaux mixture, making two applications, May 1 and 25. Up to the latter date the weather was dry. Heavy rain on May 26, and the month of June was very wet and hot. Black-rot appeared May 30, and from that time the disease developed rapidly, excepting on the Concords and Delawares, which escaped. There was no evidence that the treatments had any effect on the rot.

Mr. Justice tried the Bordeaux mixture on 140 vines, embracing a number of varieties. The application was made with a broom, May 27. "Black-rot (anthracnose) had already appeared on berries and tender branches. Mildew appeared about June 15. The black-rot (anthracnose) was arrested at once by the treatment. The powdery mildew attacked vines not treated June 15; those treated were nearly exempt from the fungus. Lady Washington and Peter Wylie were ruined in 1886 by mildew, and Noah, Wofford's Winter and Humboldt by black-rot, while this year, under treatment, they all matured a fair crop of fruit. The 'brown-rot' attacked the berries of most varieties June 20, and appeared as bad on the vines treated as those untreated."

Mr. Sneed made one application of remedy No. 1, simple solution of sulphate of copper, to 30 vines; had no mildew on his vines, either on the treated or untreated.

Mr. Bourquin made three applications of eau celeste, between June 1 and 20, but without any apparent effect on the black-rot, which was first noticed June 2.

Mr. Husted made three applications of the Bordeaux mixture June 10, 17, and 25, using 40 gallons of the preparation, at a total cost of $3.60. Rot appeared to a limited extent June 8. June 17 the berries were about two-thirds grown; a damp, rather cool, east wind prevailed for five days at this time and rot increased rapidly. At intervals there were light rains, followed by hot sultry weather, and at such times rot would take a fresh start. At the vintage the foliage on the treated vines looked a little brighter than on the others, or those not treated. In respect to rot there appears to be a slight difference in favor of the treated vines

ILLINOIS.

Twelve reports were received from the following-named parties:

Samuel Edwards, Mendota, La Salle County; Phil. Strubler, Naperville, Du Page County; T. F. Luper, Lima, Adams County; Dr. Samuel Albright, Damascus, Stephenson County; D. B. Weir, Lacon, Marshall

County; Daniel Shank, Clayton, Adams County; Edward Ressler, Shelbyville, Shelby County; W. W. Patch, Galesburgh, Knox County; Theoph. Huber, Illinois City, Rock Island County; R. Redden, Villa Ridge, Pulaski County; Geo. A. Minier, Minier, Fayette County; J. V. Cotta, Nursery, Carroll County.

Mr. Huber experimented with eau celeste made as directed in circular No. 3 of this section. The applications were made with a whitewash brush to about 250 vines of various varieties, using about 7 gallons each time, June 14, 25, and July 6. The weather was dry throughout the season and there was very little appearance of mildew or rot on any of the vines, treated or untreated.

Mr. Patch made one application of David's powder to Concord vines. The weather was so dry that there was no mildew or rot, but the foliage of the vines treated was much more abundant and held its color better than those not treated.

Mr. Ressler applied the simple solution (1 pound sulphate of copper to 20 gallons of water) to 14 vines every other day, from June 1 to 20, using for the purpose a sprinkler. There was no sign of mildew on either treated vines or those not treated. The foliage on those treated was a shade darker and heavier than those on the untreated, and their fruit was a little superior in quality. The season throughout was very dry.

One correspondent refers to the season as being the hottest and driest since 1842. This condition of the weather accounts for the nearly total absence of the rot and mildew in the State the past season.

INDIANA.

As in Illinois, the weather in this State was too dry for the development of either rot or mildew; consequently the experiments made could afford no test of the remedies employed. The following gentlemen answered to the call for reports:

J. Troop, La Fayette, Tippecanoe County; Benjamin F. Ferris, Sunman, Ripley County; J. T. Moss & Sons, Ashborough, Clay County; Edw. Yenowine, Edwardsville, Floyd County; A. Furnas, Danville, Hendricks County.

IOWA.

The same weather conditions prevailed in this State as in Indiana. Owing to the unprecedented drouth, vines did not suffer from any fungus disease, and fair crops of excellent quality were secured. The experiments made afforded no evidence of the value of the remedies, as all vines were alike healthy.

Seven reports were received:

W. Greene, Davenport, Scott County; C. L. Watrous, Des Moines, Polk County; Henrie Gourhame, Vandalia, Jasper County; Jacob Gosden, Farley, Dubuque County; N. M. Shaffer, Cascade, Dubuque County; Ernest Eggerth, Elkport, Clayton County; B. D. Halsted, Ames, Story County.

KANSAS.

There were received from this State twelve reports, from the following-named parties:

H. S. Smith, N. P. Deming, Lawrence, Douglas County; B. F. Pancoast, Iola, Allen County; Thomas E. Ashton, Holton, Jackson County; Fred. Eason, Lansing, Leavenworth County; J. A. Lindsley, New Albany, Wilson County; S. B. Farwell, Osborn, Osborn County; W. S. Prouty, Newton, Harvey County; G. F. Espenlaub, Rosedale, Wyandott County; J. B. Schlichter, Sterling, Rice County; John W. Edwards, Hampton, Rush County; A. J. Cook, Wichita, Sedgwick County.

Mr. H. S. Smith experimented with the simple solution of sulphate of copper, making about fifteen applications to Champions, Clintons, and Concords, beginning June 1. The foliage was somewhat injured by the treatment. The grapes rotted very little, and there was no injury occasioned by mildew.

Mr. Deming employed lime and sulphate of copper, 2 pounds of each in solution. Made first application June 8. Weather between the 8th and 13th very wet—rain every day and temperature high. First rot seen on the 11th, on vines which were near the ground. There was no noticeable difference between treated and untreated vines; a fine crop was gathered from both.

Mr. Pancoast treated a number of vines with the Bordeaux mixture on June 22 and 28. Mildew appeared June 21. About the time the applications were made the mildew ceased to spread on all vines, treated and not treated, consequently there was no test of the preventive value of the mixture.

Mr. Ashton made applications of the simple solution (1 pound sulphate copper to 25 gallons water) July 1 and 8. At the time of the first application grapes were in bad condition. The weather was dry at the time of the applications and afterwards. No apparent difference in the foliage between treated and untreated vines two weeks before the falling of the leaves. The wood on the former made more rapid growth and matured better. Bagged 300 bunches, with the most satisfactory result.

Mr. Eason made one application of eau celeste to 600 vines, using an old broom to sprinkle with. Total cost, $1. Mr. Eason writes:

> My vineyard is Concord and has been a total failure for three years, but I obtained a partial crop this year. I think if I had used the remedy earlier in the season I might have obtained a full crop. Early in the season the prospects were for a full crop, but about the 10th of June there were three or four days of wet weather, and in less than 24 hours there was a great deal of rotten fruit. I immediately prepared the remedy as directed, and made an application in the morning, being careful to distribute the material well. The weather at the time of the application was very close, but there immediately followed several weeks of dry weather.

There was no visible effect on the foliage from the treatment. It was too long delayed to have any effect over the black-rot.

Mr. J. A. Lindsley experimented with eau celeste, prepared as directed in circular No. 3 of this Section, making two applications, June

6 and 23, to a variety of vines. Applications made with a wisp broom. Mildew appeared on June 2 and black-rot on the 5th. There was some mildew in 1885, more in 1886. At the time of the first application grapes in many of the bunches were beginning to rot. The latter part of May and first half of June, generally moist, frequent showers, and temperature high. At the vintage the foliage on the treated vines was better than on those not treated; and the wood ripened better on the treated vines.

Mr. Lindsley concludes by saying, "I propose to try the same remedy next season, but shall begin applications earlier."

In Osborne, Harvey, Wyandotte, Rice, Rush, and Sedgwick Counties the weather was dry during the grape season and there was no mildew or rot; no applications were made.

KENTUCKY.

The two reports received from this State afford no information relative to the remedies proposed in circular No. 3.

Mr. W. Cook, of Bowling Green, Warren County, practices the bagging process, which he considers to be the only sure remedy against black-rot.

Mr. B. F. Hillenmyer, of Livingston, Rock Castle County, asserts that covering the fallen grapes about the 1st of May by turning them under with a plow is a sufficient protection from the rot in his locality.

LOUISIANA.

Four reports were received from this State from the following parties: P. L. Viallou, Bayou Goula, Iberville Parish; F. L. Streckert, Jump, Plaquemines Parish; W. Sheperd, Indian Bayou, Vermillion Parish; J. F. Spor, New Orleans, Orleans Parish.

As no experiments were made, these have no further interest in this connection. The parties reporting raise but few grapes, and it does not appear that they are seriously troubled with mildew or rot.

MARYLAND.

Only one report from this State, that of Dr. G. F. Needham, of Seabrook, Prince George's County.

Dr. Needham made three applications of the copper and lime mixtures (2 pounds sulphate copper, 2 pounds lime, to 22 gallons water), June 6, 16, and 20, to 5 acres of vines of various varieties. Cost of materials and applying the same, $5.50; cost of pump (Vermorel), $12. In 1885 and 1886 the fruit of the Concords was almost entirely destroyed by rot and the loss of Ives from the same cause was 50 per cent. Mildew and black-rot first appeared June 10. These diseases were not checked by the applications made, and "as a whole the treatment was a failure."

MASSACHUSETTS.

Three reports were received from this State from the following-named gentlemen:

Charles H. Mayo, Natick, Middlesex County; Jabez Fisher, M. D., Fitchburg, Worcester County; N. J. Stevens, Wellesley, Norfolk County.

Mr. Mayo did not experiment with the remedies proposed in circular No. 3, but he gives in his report a detailed account of the use of sulphur for the diseases of the vine. The cost of labor for application of sulphur was for 30 acres about $180. There was no appearance of mildew or black-rot in his vineyard. No comparison could be made, however, between treated and untreated vines, as all were treated alike.

Dr. Fisher experimented with remedy No. 2 (eau celeste), prepared according to directions, making two applications, the first June 6 and the second July 7. There was a trifling appearance of mildew on Concord berries July 11, and the first appearance of black-rot was noted July 7. Anthracnose was found July 8 on one cluster of Concord, also on several clusters of Wilder. He remarks that mildew has always appeared on some varieties, generally on the Concords, and for a number of years there have been slight attacks of black-rot.

Anthracnose has also prevailed to a trifling extent, but seldom on the Concord. Dr. Fisher concludes by saying that he is unable to affirm that the treatment by eau celeste has produced any appreciable effect, only that as a whole his vines are more free from disease than could be expected, judging from the character of the season and the appearance of other vines examined.

Mr. Stevens's vines were free from disease and yielded a good crop of excellent quality. No treatments were made.

MICHIGAN.

Fifteen reports received:

J. D. Baldwin, Ann Arbor, Washtenaw County; H. C. Bradish, Adrian, Lenawee County; John F. Gard, Saint Joseph, Berrien County; C. L. Whitney, Muskegon, Muskegon County; D. Woowdard, Clinton, Lenawee County; A. S. Kedzie, Grand Haven, Ottawa County; E. C. Dayhuff, Elijah Smith, Meauwataka, Wexford County; James F. Taylor, Douglas, Allegan County; O. L. Holton, Allegan, Allegan County; E. P. Allis, Adrian, Lenawee County; M. Collier, Springport, Jackson County; Albert James, Benton Harbor, Berrien County; S. W. Fowler, Manistee, Manistee County; E. B. Cochran, Parma, Jackson County.

Mr. Baldwin reports that about the middle of July, during warm rains, rot began to appear in the lower portions of his vineyard. On the 22d of July he made one application of simple solution of sulphate of copper (5 pounds to 160 gallons of water) to about 300 vines. A second application was made on the 28th; in the mean time all the rotten berries seen were picked off and burned. After the second application the weather, previously moist, became drier and the rot ceased. "It pays well to burn the trimmings and leaves, and to pick the rotten grapes and burn them."

Mr. Bradish states that the weather has been unusually dry and warm and but little mildew or rot has appeared. He made one application of simple solution, but without results, as none of his vines were diseased.

Mr. Gard, of Saint Joseph, made 3 applications of eau celeste, treating 11 acres, omitting 3 rows as a test or control experiment. The applications were begun June 21, 29, and July 11. The first mildew was noticed on June 30, appearing on both the treated and untreated vines. Black-rot was first observed July 5, on a vine which was lying flat on the ground, and on the 15th this disease was noticed on vines well up on the trellises. On one row not treated 40 berries affected with rot were found at this date, and from 2 rows which had been treated 14 diseased berries were gathered. July 19, from one row which had been sprayed—vines were vigorous and foliage very heavy—there were gathered 69 rotten berries, and from another row 43. From one row to which no remedy had been applied—vines and foliage vigorous—327 berries which had been destroyed by rot were found. Comparing the amount of rot in his vineyard, which was treated as stated above, with neighboring vineyards not treated, Mr. Gard states that from his 11 acres he gathered 1¼ bushels rotten berries. Mr. W———, from 6 acres gathered 6 barrels. Mrs. B———, from 5 acres 4 barrels, and Mr. V——— B———, from 4 acres 1½ barrels.

In the vicinity of Saint Joseph the season was favorable to the grape crop, and the damage from either mildew or rot was comparatively slight. There was a light rain on June 20 and again on July 3 and 4; other than this there was very little rain from April to September. The season was the hottest known for years.

The eau celeste was applied to some young vines—Hartford and Champion—with disastrous results. The solution burned the leaves and these vines were defoliated two weeks before the vintage.

It appears from the reports that in Michigan the vines were free from mildew and rot, owing to the dryness of the season, rendering the application of the remedies unnecessary. Where the remedies were used it was impossible to arrive at any definite conclusions in regard to the matter, as both the treated and untreated vines were alike free from disease.

MINNESOTA.

The weather in this State was dry throughout the grape-growing season and the vines remained perfectly healthy, maturing an unusually large and fine crop of fruit. No remedies were applied, as none were needed. The following gentlemen reported:

D. A. Adams, Hutchinson, McLeod, County; A. W. Sias, Rochester, Olmsted County; John S. Harris, La Crescent, Houston County; A. Kennmann & Brother, Young America, Carver County.

MISSISSIPPI.

Two reports only from this state:

J. J. Colmant, Columbus, Lowndes County; W. L. Williams, Rienzi, Alcorn County.

Mr. J. J. Colmant made no experiments with the remedies proposed, as he asserts that the circular was received too late to prevent the *Physalospora* (black-rot.) With him the Ives, Perkins, and Delawares are comparatively free from rot. He recommends that those planting new vineyards should be urged to use the preventives from the first year of planting, for when black-rot has once taken hold of a vineyard it is very difficult to eradicate. He claims to have escaped the disease for some years by burning all the trimmings and diseased bunches and making free applications of lime.

Mr. W. L. Williams says that there has been no disease of any description among his own, nor on the vines of others of his county, so far as he had been able to ascertain. He states that the Concords and Delawares are "iron clad" and have never failed in his section.

MISSOURI.

Eleven reports were received from this State as follows:

Robert Gardner, Queen City, Schuyler County; Gotlieb Segessemann, Amazonia, Andrew County; F. A. Kempt, Norwood, Wright County; J. N. Barrett, Piedmont, Wayne County; Josiah Zink, Dorchester, Greene County; Rommel & Sabbe, Morrison, Gasconade County; W. W. Daily, Beaver, Douglas County; J. C. Evans, Harlem, Clay County; Charles Patterson, Kirksville, Adair County; L. A. Goodman, Westport, Jackson County; J. R. Brown, Queen City, Schuyler County.

Mr. Gardner made two applications of simple solution of sulphate of copper. The solutions were applied with a broom, and the first application was made June 27, which was followed by a second on July 9. Ten Concord vines were treated, and black-rot appeared a few days before the first application, but did no serious injury. In a few days after the first application the foliage looked fresh and vigorous and remained in this condition throughout the season. The weather was very dry and hot.

Mr. Segessemann experimented with eau celeste, making two applications; the first June 10 and the second June 18. No results were obtained, owing to the extreme dryness of the season. There was no mildew and there was only a very slight attack of black-rot.

Mr. Kempt applied a powder composed of 4 pounds of sulphur, 2 pounds of sulphate of copper, and wood ashes (amount not given), dusting it on whenever the mildew appeared. Mildew first appeared May 24; black-rot about the middle of June. There was no appreciable effect from the treatment made.

Mr. Barrett experimented with eau celeste, making two applications to 12 vines each of Concord and Moore's Early. The applications were made with a common garden sprinkler, the first the 6th of June, and the second on the 10th of the same month. Black-rot appeared about the time the first application was made, but at the close of the season the treated vines were comparatively free from rot, while on those not treated the berries rotted more than in any previous year.

Mr. Zink made two applications of simple solution of sulphate of copper on June 7 and 14. Many of the grapes were affected with rot at the time of the first application. About the last of June the foliage looked rusty and sun-burnt, and by the time the fruit ripened many leaves were dried up so that the grapes did not mature perfectly. There was no visible effect produced by the applications of the remedy.

Messrs. Rommel & Sabbe made an application of simple solution of sulphate of copper. The grapes did not rot, owing to the dry weather, but the vines lost some of their leaves and the fruit did not ripen well. This result was possibly due to the caustic properties of the solution applied.

NEBRASKA.

Mr. Hiram Craig, of Fort Calhoun, Washington County, reports that owing to the protracted drought during the grape season his vines were not troubled with either mildew or rot. He made no experiments.

Mr. W. S. Dilworth, of Crab Orchard, Johnson County, applied the Bordeaux mixture with a broom to 20 vines, Concords and Wordens, on June 1, July 1, and August 1. There was no appearance of mildew at any time. A very few grapes were affected by black-rot about the 1st of July. Owing to the dry weather throughout the season there was little opportunity for testing the merits of remedies for fungus diseases.

NEW JERSEY.

Eight reports were received from New Jersey:

George W. Fisher, E. Williams, Montclair, Essex County; F. S. Conover, Princeton, Mercer County; Edward Harris, Moorestown, Burlington County; George W. Jessup, Cinnamonson, Burlington County; Joseph Nehr, Egg Harbor City, Atlantic County; J. R. Shotwell, Rahway, Union County; D. Aug. Vanderveer, Manalapan, Monmouth County.

Mr. George W. Fisher sent in a very full report of his experiments and the results obtained. He used eau celeste for the downy mildew, making the applications June 29, August 3, and August 17, with a wisp broom. The vines treated were 1 Brighton, 1 Wilder, 1 Salem, 1 Isabella, 1 Niagara (a young unbearing vine), and 1 Bachus. The material for the first application contained 2 ounces sulphate of copper and 2 ounces ammonia to 2½ gallons water. With this the vines were thoroughly drenched, application being made to both sides of the leaves and to the stems and fruit. This treatment burned the foliage badly.

The solution used for the second and third applications contained only 1 ounce sulphate copper and 1 ounce ammonia to 2½ gallons water. This did not burn the leaves. The first appearance of the mildew was on July 30, on a Brighton vine left untreated for comparison. Mildew was noticed on the treated vines August 1. Black-rot was observed on the Bacchus early in the season, but the attack was slight. There was considerable mildew on the vines in 1885 and 1886, especially on the Brighton. At the time of the first application the vines were in fine condition. This application injured the foliage as already stated, but the vines fully recovered from its effects. There was a slight spotting of mildew on the new growth at the time of the second application.

At the vintage the foliage on the treated vines was in "splendid condition," while that on vines untreated, left for comparison, was half gone, and the leaves remaining were curled up with disease. Mr. Fisher here remarks that when he looked from vine to vine he became convinced that had he not used the mixture he would have had only a "crop of bare canes and green fruit."

The foliage on the treated vines two weeks before the falling of the leaves was still in good condition as compared with that of those untreated. On the latter a large proportion of the leaves had fallen and the fruit still remained green. The difference was so decidedly in favor of the treated vines that Mr. Fisher says that he will in the future leave no more of the fine fruited sorts untreated for the sake of comparison.

"The month of July in this section was a terror to grape-vines," Mr. Fisher writes: "there were frequent heavy rains and excessive humidity of atmosphere throughout the month. The ground was kept constantly saturated even at points ordinarily dry. The same weather conditions prevailed for the greater part of August."

Mr. Edward Harris made two applications of eau celeste, June 13 and 29, to about 40 vines, the varieties being Brighton, Pocklington, and Concord. The material for each application cost about 20 cents. First appearance of mildew about July 1, of black-rot about July 15. The Brighton has always mildewed in previous years; the Pocklington has mildewed a very little, but its fruit has never rotted to any serious extent, while the Concords lost nearly their entire crop from rot in 1886. The season (1887) has been rainy, but on the whole has been a better grape year than was that of 1886. The treatment gave no appreciable results. Anthracnose was observed on the berries of Brighton July 4, and later on those of Pocklington, both on the treated and untreated vines. Three vines of Eldorado lost two-thirds of their berries and many of the ends of the bearing shoots were affected with this disease.

Mr. Joseph Nehr experimented with the simple solution sulphate of copper, prepared as directed, making three applications, June 19, July 6, and July 22, to 2,000 Concord vines, covering 2 acres. The amount of materials used was 10 pounds of sulphate of copper per acre, and the solution was applied with a wisp made of green twigs. Cost of material used, $1 per acre; cost of labor, $3 per acre. The date of the first appearance of mildew was June 23, of black-rot June 26. The condition of the vines in respect to disease in 1885 and 1886 was fair. Condition at time of first and second applications, good. At the time of the third application the young tips of the vines were slightly injured by mildew. The weather at the time of the first application and immediately following was fair; at the second application cloudy; at the third fair, immediately followed by cloudy weather and heavy rain. The foliage of the treated vines at the time of vintage was fresh and green in color, while that of vines not treated had a dusky green color and looked sickly. The foliage on the treated vines two weeks before the usual falling of the leaves was quite green, while that on vines untreated was withered and nearly half fallen to the ground. Mr. Nehr concludes by stating that the results were good as respects mildew, but the applications had no effect whatever on black-rot the latter disease destroying more than three-fourths the entire crop.

Mr. Shotwell states that he experimented with the simple solution sulphate of copper, carefully following directions as given in circular No. 3 of the section of vegetable pathology, but without any benefit resulting therefrom. All his vines were more affected with mildew this year (1887) than he had ever seen them before in an experience of thirty years.

Mr. Vanderveer experimented with the simple solution and eau celeste, applying each to one-half acre of vines May 27 and June 10. His vines were not all affected with mildew, but black-rot attacked the berries when the latter were about half grown. The solutions burned the foliage badly, causing the leaves to wither and die. However, at the time of vintage, the foliage on the treated vines was better than on those not treated. The remedies had no effect on the black-rot. As soon as the blossoms had fallen Mr. Vanderveer bagged a large number of clusters (10,000), but he only saved a small part of his crop, as the bagging did not prevent the rot.

Mr. E. Williams experimented with remedies 2 and 3 (eau celeste and Bordeaux mixture), prepared as directed in circular No. 3. On June 8 and 9 he painted the posts and stakes of his vineyard with the Bordeaux mixture, and on the 10th the mixture was applied to the foliage of the vines. This application was made with a Field force-pump, the nozzle of which gave a sprinkle instead of a spray, and there was a considerable waste of material. Mr. Williams goes on to say:

> I then procured a climax nozzle, made by A. H. Nixon, of Canton, Ill., and fitted this to my pump. This promised a success on trial with water, but the fine particles of lime in the Bordeaux mixture clogged the nozzle so that the spraying was tedious and laborious work. I then strained the mixture, which improved matters, but still the action was far from satisfactory. The pump was secured to the bottom of a large tub containing the mixture and the whole mounted on a wheelbarrow and wheeled through the vineyard by an assistant, but the working of the pump made the operation a laborious one for both of us.
>
> On July 4 I discoved the first appearance of mildew, and for some ten days it seemed to be confined to the two vines where first seen. These vines were immediately sprayed with the mixture.

In the mean time, owing to the difficulties attending the spraying of the Bordeaux mixture, I made a preparation of eau celeste, as promising to be more easily made and applied. I also obtained a small brass hand-pump and fitted it to the climax nozzle. This was far more satisfactory as far as labor was concerned; my assistant following me with a pail full of the mixture in which was the suction end of the pump hose. A little lime was added to the solution in order to show on the foliage where it had been applied. On July 1 a thorough application of the solution was made. The previous treatment of the two affected vines seemed to have checked or killed the mildew. The week following this application of eau celeste it rained daily, very heavy at times, flooding everything. On the 17th there was a heavy shower and cyclone, very hot and close, mildew and rot appearing everywhere. Partial applications of eau celeste were made at intervals in hopes that some of it would escape the rains. July 23, mildew and rot appeared with increased virulence. July 26, made another thorough application of eau celeste. Days of the 26th and 27th clear, but showers during the night, atmosphere hot and muggy. Mildew appeared to be partially checked. August 2, showers daily, still hot and muggy. Rot continues and mildew is developing freely all over the vineyard. August 4, weather damp, but cooler, mildew spreading like fire; at this rate about three days will suffice to cover the whole vineyard. Made application of eau celeste to part of my vineyard to see if it would stop its ravages. August 5, finished the application began yesterday. The Bordeaux mixture applied June 10 still adheres to the under surface of the leaves, and it is difficult to find any such leaves affected with mildew. August 6, showery. August 8, the eau celeste does not appear to have the effect on the mildew that it did. The fungus continues to grow and spread. When the grapes began to ripen in September many of the leaves were curled and dead. After a heavy rain in the latter part of September, the fruit being about half colored at this time, remained so. The Niagaras, which comprised the bulk of the vines treated, though badly mildewed, retained enough foliage to ripen their fruit very well, but later than usual. Isabellas and several of Rogers' hybrids not treated lost their foliage sooner than the Wilders, but no worse. I try to believe that there was some virtue in the applications, though I failed to find them as efficacious as I was led to believe from the French testimony. Without these applications I might have lost my whole crop, so I gave them the credit of saving it.

Mr. Williams says that the behavior of the Wilders was a puzzle to him. Their treatment was as thorough as that of the Niagaras, and he asks, "Was their foliage less susceptible to the disinfecting qualities of the copper sulphate, or were the doses given too strong for them, or have they less tenacious leaves than have the Niagaras?" It may be that the leaves of the variety in question are less firmly attached to the canes than those of the Niagaras, but the cause of their early fall was most likely due to the action of the eau celeste upon them. This preparation has frequently produced such results, as may be seen by the reports of others.

It is suggested that the frequent rains may have washed the solutions from the foliage, and thus arose the want of success attending the experiments. This may have been the case to a considerable degree. The copper solutions, Bordeaux mixture and eau celeste, if permitted to become thoroughly dried upon the leaves, are very strongly adherent, resisting heavy rains; and, further, it has been affirmed that although the material actually on the surface of the foliage may be subsequently washed off, a sufficient quantity of the copper salt penetrates the cuticle of the leaves to make them, for some time at least, impenetrable to the germinating spores. These preparations have little or no effect in preventing the mildew if applied only to the under surface of the leaves. It is upon the upper surface that the spores of the fungus fall, and if there be nothing in the way to prevent, they will germinate and quickly penetrate the tissues of the leaves. What material may be on the under side of the leaves interferes very little, if at all, with the vegetation of the fungus. The leaves showing the mildew July 4 were infected some days before that date, for a certain period of time must elapse between the penetration of the germinating spores into the tissues of the leaves and the fruiting of the fungus arising from these spores; it is only when the fungus has reached this latter stage that it becomes visible to the naked eye. At the time when the parasite began to fruit on the leaves where it was first discovered by Mr. Williams, half the leaves in his vineyard might have had germinating spores of the downy mildew upon their surfaces, while in very many of them the fungus might have already commenced to vegetate, secure from the reach of fungicides. The subsequent development of the disease showed that this was, to a certain degree at least, the case.

In comparing our experience with the reports received from France, we should remember that in grape-growing regions of that country there is usually very little rain during the summer, and a season like that which prevailed in New Jersey in 1887, has rarely if ever occurred. Such weather in France would lead to much greater disaster, owing to the varieties there cultivated, than is possible in our vineyards. When the season is so very wet three applications are not enough; five or six should be made, and they must be made so that they may act as preventives, for they can act in no other way. The sulphate of copper should be spread over the leaves before the spores of the fungus come upon them, for the value of the solutions rests entirely upon the fact that they will prevent the germination of the spores or destroy the product of germination before access is gained to the interior of the leaves.

NEW YORK.

From New York ten reports were received:

Josiah Shull, Ilion, Herkimer County; J. H. Sherman, Ithaca, Tompkins County; George S. Jesselyn and H. S. Huntley, Fredonia, Chautauqua County; J. M. Hanable, Naples, Ontario County; J. W. Corbett, Watkins, Schuyler County; J. H. Butler, Seneca Grape Company, Penn Yan, Yates County; William D. Barns, Middle Hope, Orange County; L. I. Young, Fredonia, Chautauqua County; J. W. Thomas, Newburgh, Orange County.

Mr. Barns experimented with the Bordeaux mixture in 1886 and 1887, making one application each year. He concludes his report by saying that while my two seasons' trial of the solution of sulphate of copper as a preventive of mildew are not conclusive, I am so convinced of its value that I shall continue to use it.

Mr. J. H. Butler made one application of the Bordeaux mixture for black-rot. There was but very little more rot, if any, where the remedy was applied than where it was not.

Mr. Hanable employed eau celeste, but neither the mildew nor rot appeared on any of his vines, so there was no test of its value as a remedy.

Mr. H. S. Huntley, reporting for Cattaraugus County, says that there has been no appearance of mildew or black-rot, and consequently there has been no occasion for experimenting with remedies.

Mr. Sherman commenced applications of eau celeste to a few vines July 24. Mildew had already made considerable progress on the Delawares and Catawbas. There was no further spread of the mildew, "but a blight, like scorching of leaves, continued to some extent through August, making the ripening late and rather imperfect." This "scorching of the leaves" was probably caused by the preparation used. (See reports of others.)

Mr. Shull "bountifully sprayed a number of vines with the simple solution of sulphate of copper (1 pound to 25 gallons) on the morning of May 30. The weather was warm and fine. The effect was that on the following day much of the foliage withered and turned brown. Five or six days later many of the sets for grapes began to drop, the more tender varieties yielding first, so that not half a crop was realized." This effect from applications of the simple solution has so frequently occurred that we think its use should be discarded entirely as "dangerous." Instead of adding more water to the solution or diminishing the amount of the copper sulphate, we would add to the solution lime or carbonate of soda, in order to reduce its immediate caustic effects. It is believed that eau celeste, prepared as described in Circular No. 3, with the addition of 1 pound of carbonate of soda, will prove as effectual in combating the mildew as any remedy proposed, and be perfectly harmless to the leaves.

Mr. J. W. Thomas made three applications of the Bordeaux mixture June 3, 7, and 13. Mildew was first noticed June 7 on Wilder, Delaware, Ionia, and Early Dawn. At this time there were several days of cold, wet weather. The season throughout was very hot, with frequent showers. All vines suffered more or less from mildew, although not to the same extent as they did in 1886.

Mr. Young used the Bordeaux mixture, making four applications to about 8 acres of vineyard and 3 acres of vines in nursery. The preparation was applied with an ordinary broom, on June 16, July 7, 18, and 30. At the times when the applications were made the weather was clear, and there was very little rain during the season, excepting between the 18th and 30th of July. Cost of treatment per acre of vineyard, $1.75. At the vintage the foliage of the treated vines was perfectly healthy, while those not treated had already dropped a portion of their leaves. Two weeks before the usual time for the falling of the leaves the difference in foliage between the treated and untreated vines was very marked, decidedly in favor of vines treated.

NORTH CAROLINA.

From North Carolina six reports were received:

W. B. Fleming, superintendent for J. M. Heck, Ridgeway, Warren County; H. Bilyen, superintendent for J. M. Heck, Raleigh, Wake County; J. W. Scott, Ridgeway, Warren County; William Murdock, Salisbury, Rowan County; J. A. May, Pigeon River, Haywood County; J. H. Jenkins, Whittier, Swain County.

In this State, as in New Jersey, Maryland, and Virginia, the weather during the grape season was particularly favorable for the development of rot and mildew of the grape. In each of these States black-rot was particularly prevalent and destructive. Experiments were begun by myself in the vineyard of Hon. Wharton J. Green with all the preparations named in circular No. 3. The first applications were made about the 27th of May, but at this early date the effects of the fungus of the black-rot was already manifest upon the foliage, and the fruit of some varieties were already affected. Other applications were made during the season, but they gave little evidence of being of any value in checking the rot. The sulphatine was applied too heavily and with too little regard to the state of the weather, and the result was that it njured the foliage and young fruit quite severely. There was very little or no mildew in the vineyard, although it was abundant and destructive in 1886, so there was no test of the remedies for this disease.

Several days were spent in this vineyard towards the latter part of July, and it was at this time that the fungus of the bitter-rot was discovered, accounts of which have already been published. This attacks the fruit near the period of ripening and was particularly destructive to the fruit of those vines which had been weakened in 1886 by severe attacks of mildew. During the prevalence of this disease the weather was very hot and heavy showers occurred daily. Bitter-rot appears to have been known to grape-growers in the Eastern States for several years past, at least since 1876, but the cause of the disease was not known until discovered and pointed out by Professor Viala and myself the past season.

Mr. Murdock made one application of eau céleste, on the 8th and 9th of June, to 1,100 vines of about 50 varieties. The application was made with a watering-pot to low vines and with a syringe to vines on trellises. The only effect noted was that the foliage was considerably injured by the solution. Black-rot was first noticed May 27 on the Clinton, and by June 7 it was quite general, appearing on many varieties. It appears that eau celeste, prepared according to the orignal formula, is unsafe from its liability to burn the foliage. It is stated that this danger in its use can be wholly obviated by adding to the solution of 25 gallons 1 pound of carbonate of soda.

Mr. Scott made one application of eau celeste on June 10. Black-rot had already appeared on the 3d of the month, and by the 20th the fruit was so far gone that further applications were deemed useless.

Mr. Fleming, superintendent for Col. J. M. Heck's Ridgeway vineyards, reports that he experimented with the simple solution (stronger than recommended) and the Bordeaux mixture for mildew and black-rot The applications were begun June 6. The strong simple solution burned the foliage badly, and every grape touched by it dried at once. Three applications of the Bordeaux mixture were made during June to 1,300 Delaware vines. Mildew appeared on these vines about July 1 and increased so that few grapes were gathered from them. The simple solution did much harm, and the Bordeaux mixture appeared to do no good.

Mr. Bilyen, superintendent for Colonel Heck's Raleigh vineyards, experimented with the Bordeaux mixture, making but one application, June 18. At this date the Duchess had commenced to rot. At the vintage the foliage of the treated vines was in a healthy condition, in strong contrast with that of those not treated. September 27 there was still a marked difference in the foliage in favor of the treated vines.

OHIO.

During the past season the weather was unusually dry from the period of bloom until near the time of ripening of the fruit, so that the vines were almost wholly free from the attacks of mildew and black-rot, and there was little or no occasion for the use of remedies. Where applications were made the weather conditions prevented any manifest results of their value to appear.

The following are the names of those who reported:

Jacob Kelley, Pulaski, Williams County; Thomas Shroyer, Preston, Hamilton County; J. Huston, jr., Hazelwood, Hamilton County; Joseph Allen, Gano, Butler County; George J. Streator, Ganettsville, Portage County; E. A. Prior, Cuyahoga Falls, Summit County; C. Lauppe, Urbana, Champaign County; E. H. Cushman, Euclid, Cuyahoga County; Charles Carpenter, Kelley's Island, Erie County; E. W. Trowbridge, Glendale, Hamilton County; S. W. Smart, Willoughby, Lake County; George C. Townsend, Zanesville, Muskingum County.

The first six on the list made no applications at all, for the reason that none appeared to be needed.

Mr. Trowbridge reports having made frequent applications of remedies 1 and 5, beginning May 28, at which time mildew first appeared on Herbert (Rogers' No. 44). Both remedies seemed effective in checking the mildew. As to black-rot, there was no opportunity for testing their value, as the fruit was entirely free from this disease.

Mr. Townsend made applications of eau celeste on the 5th of July and again on the 22d, using a broom for a sprayer. The foliage was evidently injured by the treatments. The vines not treated presented about their usual appearance of health and freshness, while those treated became more discolored as the season advanced.

Mr. Smart also made two applications of eau celeste on June 28 and July 12. No effect of the remedy in respect to rot was observed, as the disease did not appear on the vines. No injury to the vines from the use of the mixture reported.

PENNSYLVANIA.

Two reports were received from this State, one from Mr. J. L. Dillon, of Bloomsburgh, Columbia County, who made no treatments, none being required, and one from Mr. John C. Weiser, of York, York County.

The statement of the latter gentleman is as follows:

May 4.—Dissolved 1 pound of sulphate of copper in 4 gallons of warm water. When cooled off added 1 pint of commercial ammonia; then put the solution in a keg, ready to dilute and use. Cost of material:

1 pound sulphate of copper	$0.12
1 pint commercial ammonia	.20
Total	.32

June 2.—Diluted 1 quart of the solution to a gallon, and applied to 100 Concord and 40 Catawba vines, with a wisp made of broom-corn. Did not notice any mildew or black-rot at the time of first application. Left one row of vines untreated; next row following had been tied to the wire with osier bark that had been steeped for 24 hours in the solution previous to being used.

June 6.—Made second application to vines treated on the 2d. No appearance of mildew or black-rot at the time of second application.

Our locality was visited with a warm shower on the 17th and a continued rain on the 18th and 19th.

On the 24th discovered a slight appearance of mildew on the vines not treated, mostly Catawbas and Rogers' hybrids, but those tied up to the wire with the soaked osier bark did not show the least, neither those which were treated with the solution.

July 14.—I noticed the black-rot had made its appearance on the untreated Catawba vines, nearly all the grapes having small brown spots on them, and continued on to the close of August, at which time the grapes had most all fallen off. The leaves also commenced to turn brown and drop off. By September 3 the part not treated was lost, and not a leaf remaining on the Catawba vines, and the Rogers hybrids were not much better. The grapes of the latter are covered with mildew and the leaves fall in great numbers. The vines treated with the solution were still quite green, and well provided with foliage.

September 15.—The vines treated have a normal vegetation; the leaves are healthy and of a fine green; the grapes are perfectly ripe. On the other hand, the vines not treated present a most miserable appearance. The greater part of the leaves have fallen and the few that remain are partly dried up. Some grapes from these vines were put in paper bags when half grown, but these are no better. I notice the wood on the treated vines has a nice brown, ripe color. The untreated vines show a vast difference; the wood is green and very much affected with mildew. In 1885 I did not have any mildew or black-rot on any of my vines; 1886, mildew only slight, black-rot very bad on Catawba vines.

TENNESSEE.

Two reports of efforts made to check black-rot were received from Tennessee, one from Columbia, Maury County, by Mr. Josh. G. Bailey, and one from Medina, Gibson County, by Mr. C. M. Merwin.

Mr. Bailey used eau celeste, making two applications, May 24 and June 15, to 120 vines, chiefly Concords, at a total cost of $1.25. The first appearance of the rot was on May 15 (9 days before the first application). In 1885, owing to the dry weather, rot was slight, but in 1886 nine-tenths of the crop was destroyed by this disease. There was no evidence whatever of any beneficial effect derived from the applications made.

Mr. B. bagged 3,000 bunches, and these matured in perfect condition and "were the admiration of all who saw them, and sold at retail for 12½ cents per pound, when others were selling the same variety at 3 and 4 cents." He has experimented some with sulphate of iron sowed broadcast in the vineyard, and he concludes his report by saying:

> Now I firmly believe from my experience with sulphate of iron that if it be used three years in succession, being careful to pick and destroy all rotten grapes, the rot will be exterminated from the vineyards, if the vineyard is not contiguous to other affected vineyards.

It should be noted that the black-rot had already appeared in Mr. Bailey's vineyard 9 days before the first application was made, and consequently there was no test made of the efficacy of the remedy employed, for whatever action any remedy may possess it can only be in the way of prevention. The course of treatment with sulphate of iron and the careful gleaning of diseased berries ought to result in a mitigation of the evil, but it scarcely seems practical to destroy all the germs of infection which may exist in a vineyard when we know that the fungus breeds upon the leaves and young shoots as well as upon the berries. If it were only in the latter it would scarcely be possible not to miss some infected ones, however careful one might be in seeking to collect and destroy them. It is only in vineyards of very small extent that one can apply this course of treatment or hope to carry it out with sufficient care to prove its real value.

Mr. Merwin made one application, May 21, of simple solution of sulphate of copper to 10 vines of Concords, and on the same date applied David's powder to 10 vines of the same variety.

The simple solution, made slightly stronger than recommended, scorched the foliage considerably, and on some vines shriveled the fruit. Rot appeared within five days after the applications were made, on both treated and untreated vines.

Mr. Merwin bagged 15,000 bunches, and these were entirely free from rot. He thinks bagging the only sure remedy for this disease.

TEXAS.

From Texas eight reports were received. The following are the gentlemen who sent reports:

T. T. Gansmage, Palestine, Anderson County; J. H. Krancher, Millheim, Austin County; Jesse Johnson, Camp Colorado, Coleman County;

W. H. Bristol, Fayburgh, Collin County; George H. Hogan, Ennis, Ellis County; Sam F. Gaines, Pilot Point, Denton County; M. F. Bates, Marquez, Leon County; William Radam, Austin, Travis County.

Mr. Bates made three applications of the simple solution of sulphate of copper, remedy No. 1, between June 10 and 20, at which time all his vines were in fine foliage and berries well set. Drought set in towards the last of June, then an effect of the treatment became manifest. Vines not treated ripened their fruit seven or eight days earlier than those treated, and the berries were somewhat shriveled. The treated vines stood the drought perceptibly better, the fruit remaining full and plump.

Mr. Radam's vines were attacked by "dry-rot" (black-rot?) and he made (too late) three applications of the simple solution of sulphate of copper, "but rot spoiled the whole." "The best preventive for dry or black rot is bagging every bunch as soon as possible after bloom."

VIRGINIA.

The grape growers in Virginia were particularly active in experimenting with the remedies recommended for trial, and fourteen reports of experiments made were received from that State, the greater proportion coming from Albemarle County, which embraces a region especially well adapted to grape growing. Those who reported are:

William Hotopp, J. W. Porter, John M. White, Charlottesville, Albemarle County; A. L. Holladay, H. M. Magruder, Eastham, Albemarle County; W. Gordon Merrick, Glendower, Albemarle County; William Dinwiddie, Green Wood, Albemarle County; Adolph Russow, Proffit, Albemarle County; H. Taylor, Shadwell, Albemarle County; R. E. Buffum, University of Virginia, Albemarle County; Peter Traser, Granite, Chesterfield County; H. W. Hey, Richmond, Henrico County; F. Lentz & Co., Montreal, Nelson County: Albert Dodge, Woodside, Norfolk County; Joseph Wetzel, Ruckersville, Greene County; S. H. Stratton, Gordonsville, Orange County; Van Opstal & Co.,* 408 Madison street, New York City.

Van Opstal & Co., who own vineyards in Spottsylvania, report that they have tried for black-rot all the remedies with sulphate of copper and iron, also with lime, sprinkling the bunches carefully with the preparations, but without any beneficial results. By way of experiment glue was added to the solution to make them adhere to the grapes, and this treatment was immediately followed with a thorough dusting of flowers of sulphur, but the berries thus treated rotted as did all others. In spite of the failure of the past season's experiments, these gentlemen state that they will keep on making new trials next season and hope for better results.

We suggest that they set apart, say, 2 acres of their vineyard for special treatment. On one acre, apply eau celeste, prepared according to the formula given on page 42, every ten days for two months, beginning as early as the 10th of May. Treat the second acre exactly in the same manner with the Bordeaux mixture (formula on page 43). It is important that the spraying should be done thoroughly and well. This does not mean that the vines should be *drenched* with the solutions, but all parts should be made wet with them and nothing more. With a good portable pump having a suitable nozzle, like the Vermorel nozzle, the spraying may be done quickly and effectually.

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*Vineyards in Virginia.

It is possible that many will try just such a course of treatment as here suggested the coming season. It is certain that the results will be watched with great interest.

Mr. R. E. Buffum experimented with eau celeste prepared by dissolving ½ pound sulphate of copper in 2 gallons warm water, and when cold adding ½ pint commercial ammonia, diluting for use to 9 gallons. He made two applications, the first May 26, the second June 8, using for the purpose a Lewis's agricultural syringe. The number of vines treated 200, viz: 12 Salem, 12 Agawam, 12 Champion, 2 Lady, 4 Catawba, and 158 Concord. A certain number of vines were left untreated for comparison.

There was a rain-fall on the 25th of May of 2.8 inches, and again the same amount on the 26th. From this date to June 8, when black-rot was first noticed, the rain-fall was 4.15 inches. After June 8 the weather was hot and dry until the 17th, after which date there were daily rains until the 24th, with a temperature ranging from 96° to 99°.

On June 8, the date of the second application, 500 2-pound bags were pinned over the young clusters on the treated vines. The fruit thus inclosed matured for the most part in good condition. Berries exposed all rotted to a greater or less extent according to variety.

The mildew appeared at about the same time as the rot. It made but little progress up to nearly the maturing of the fruit, when it advanced rapidly on the Salem, Agawam, Lady, Catawba, Concord, and Champion, affecting each in the succession named. In 1885 all vines were injured by mildew, but not seriously. In 1886 the Salem was entirely stripped of foliage by mildew when the berries were one-half or two-thirds grown. The berries shriveled up and were a total loss. This year the foliage on the Salem vines treated has been retained in fair condition, and the grapes were taken from the bags fully matured before the leaves dropped. The foliage on all treated vines is better than on those untreated.

The conclusions arrived at by Mr. Buffum were that eau celeste is decidedly beneficial in preventing mildew, but has no effect on black-rot.

Mr. Hotopp used a solution of sulphate of copper and lime (16 pounds sulphate of copper, 20 pounds lime, 50 gallons water). In one part of his vineyard mildew appeared May 29. Here he made four applications, viz, June 1, 15, 20, and July 6. The crop on these vines had been destroyed by mildew and rot for the past four or five years. Owing to the treatment, Mr. H. says, he secured this season 3½ pounds per vine of good grapes. The expense amounted to $1.50 per acre for each treatment.

In another part of the vineyard, where only one application was made, and that later in the season, the result was not so good; however, it saved the leaves from mildew. Where four applications were made the foliage remained in a healthy condition until destroyed by frost. On older vines, which received no treatment, the leaves dropped about the last of August.

The mixture used by Lentz & Co. was made by dissolving 16 pounds sulphate of copper in 22 gallons water and 10 pounds lime, using only water enough with the latter to slake it previous to mixing it with the copper solution. This was applied to about 10 acres of vines composed of Concords and Nortons, the first application being made on the 8th of June, the applications being repeated weekly until July 22.

In their report they state: "We had no mildew at all this year, and the foliage on all the treated vines is exceptionally green and healthy at this date (September 24). Black-rot appeared on June 5 (three days before the first application), but in rather a mild form. Other attacks of this disease were manifest on June 22, July 4, and July 21, but no material damage was done. On July 26 there was a brief period of damp, sultry weather, and then it was that the vines suffered heavily from rot, destroying at this time fully one-half of the Concords and about 10 per cent. of the Nortons. In 1885 three-fourths of the crop of all varieties was destroyed by black-rot. The vines under treatment this year have been very luxuriant as compared with previous years or with some fifty vines this year which were not treated. The wood has ripened remarkably well.

Mr. J. W. Porter first experimented with the simple solution of sulphate of copper on a few Niagara vines, the foliage of which was badly injured by the application.

Upon 2 acres of Concords and Niagaras he applied, on June 2, eau celeste. Later, on the same plot, he applied a modified Gironde mixture (2 pounds sulphate of copper, 2 pounds lime, 22 gallons water). There was also applied to the same area 900 pounds of ground sulphate of iron. Mr. Porter concludes that the remedies "will prevent mildew (which has seldom injured his crop to any great extent), but as respects black-rot their use resulted in no perceptible benefit." He refers in his report to the apparent beneficial results obtained from the use of the remedies in the vineyards of Messrs. Lentz & Co. and Mr. Hotopp, the latter being situated not far from his own, and he suggests: "May it not be that in these vineyards, both of which were devastated by disease years before my own, were entering upon another cycle, convalescing from the disease?"

This view is not tenable, for the black-rot is not, strictly speaking, a disease of the vine, but the effect of the action of a parasite upon it. The vine is in no wise sick, hence it has nothing to recover from. The fungus demands for its growth and development only the proper food for its nourishment and a suitable degree of temperature and amount of moisture. It finds its proper food in the vine, particularly in the growing berry of nearly all of our cultivated varieties of grapes, and the favoring conditions of humidity and heat are rarely lacking during some portion of the growing season in our Eastern States.

It is possible that the vital powers of the fungus may become in a degree exhausted in vineyards where it has vegetated for a number of years with an excess of vigor; were this the case, however, in the vineyards of Messrs. Hotopp and Lentz & Co., the abundance of the spores in those adjoining would have been amply sufficient to destroy all their crop had these spores met with no obstruction to their germination or subsequent development. Whether this obstruction consisted in the material applied by these gentlemen to their vines or resulted from other causes, repeated experiments will be necessary to determine.

Report of Mr. Adolph Rossow:

I experimented with eau celeste and Bordeaux mixture in the treatment of grapevines for mildew and black-rot. The remedies were prepared as directed in circular No. 3, and applied with a Lewis force-pump. With eau celeste I treated, on June 17, 400 vines (Nortons), using 40 gallons of the mixture—my pump did not give a very fine spray. The Bordeaux mixture was applied in the same manner July 17 and 18 to 1,100 Norton vines.

Cost of materials used: Sulphate of copper, 5½ cents per pound; lime, $1.20 per barrel; ammonia, 15 cents per pint. Cost of labor in preparing and applying the mixtures, $1.75 per acre of 400 vines.

Only one application was made of eau celeste, for on the plot where this material was used I noticed on the 22d of June the leaves were somewhat discolored, and soon after some of them dropped off.

Only one application was made of Bordeaux mixture. First appearance of rot June 8; this however did little damage, but a second attack about July 4 was very severe, completely destroying the berries of Martha, Concord, Clinton, and affecting the Ives to a greater extent than last year.

My conclusions are that the Bordeaux mixture is a complete success so far as the treatment of mildew is concerned, and I have no doubt that if it be applied early and the applications repeated a number of times it will check the rot somewhat.

I sowed broadcast among my Concord, Martha, and Clinton vines powdered sulphate of iron and wood ashes, making two applications, June 9 and 16, but vines thus treated rotted just as badly as those not treated.

Mr. Merrick experimented with a modified Bordeaux mixture, 12 pounds sulphate of copper, 4 pounds lime, to 36 gallons of water—concluding his first applications May 18, using on 700 Ives and 200 Concords 24 pounds sulphate of copper and 8 pounds lime. The application was made with a Vermorel pump. Made a second application to the Concords June 2 and included in this treatment 80 Nortons. A third application was made June 20 and 21. Mr. Merrick states that he was away from home at this time, but returning about the 25th he found "many of the Ives and some Nortons almost denuded of leaves." At this date (June 25) a little black-rot was observed, but before the berries ripened the loss from this disease amounted to fully one-third of the crop. The foliage of the vines evidently suffered from the applications of the mixture used and black-rot was not checked by it.

The report of Mr. Magruder is so direct and so strictly in acccordance with the series of questions sent out by the Department with the report blanks that it is presented as received:

I have experimented with remedies Nos. 2 (eau celeste) and 3 (Bordeaux mixture) in the treatment of mildew and black-rot of the grape. I used No. 2 prepared as directed in circular No. 3 and remedy No. 3 full strength and one-half strength. Treated with No. 2, Norton's Virginia; with No. 3, Nortons, Ives, Clinton, Jefferson. Goethe, Brighton, Catawba, Diana. Area covered 20 acres. Amount of material used: 1 gallon ammonia, 150 pounds sulphate of copper, 1 barrel lime. Cost of material: Sulphate of copper cost 5½ cents per pound; ammonia, 75 cents per gallon; lime, $1.10 per barrel. Cost of labor, $1 per acre. Date of first application, June 6 to 15; second, July 7 to 12. First appearance of mildew June 6; this was stopped by the copper remedies, but began again about July 6. First black-rot seen on clusters June 8; all kinds rotted badly till about 22d, when dry, warm weather coming on rot ceased, but reappeared about July 5 or 6, sweeping off most of the grapes left first time.

In 1885 this vineyard had a little rot and some mildew, though not enough to seriously affect it. In 1886 the rot injured the crop 25 per cent., but the mildew was much worse, damaging the Nortons 50 per cent. Ives have never been affected by mildew.

At date of first application there was a little mildew on the Norton, the grapes were about the size of a No. 4 shot, the growth rather weak, and set of fruit poor in consequence of bad wood from mildew of the previous year. Ives and Clinton strong, Goethe very vigorous, Jefferson and Brighton feeble from mildew of year before. At second application the young leaves of the Norton had considerable mildew, none on the older ones that had been sprayed; no mildew apparent on any of the others. The rot very bad on many of the Nortons; Clintons, 50 per cent. rotted; Ives, 20 per cent. rotted; all the others more or less affected.

The weather at the first application, from May 29 to June 11, rain every day except 3d, also fog, etc., with intervals of hot sun. The weather continued showery and damp until June 22. At second application a shower on the 3d, July 5, damp and cloudy; 6th, cloudy and rain; 7th, foggy and hot.

Condition of foliage at date of gathering grapes: Nortons first rate, where two applications had been made; fair where only one was made, and very bad where the vines were not treated. Clinton, foliage very poor, but do not think it was mildew that caused leaves to drop. Goethe, Jefferson, etc., fair. New wood well ripened, and if rot can only be kept off a good prospect for a crop another year. My experience seems to show that the rot was not at all diminished by either of the remedies used, but that both are effectual preventives of mildew on all the leaves, twigs, etc., on which they are applied."

Mr. William Dinwiddie experimented with eau celeste prepared and applied as directed in circular No. 3. He made two "liberal" applications, June 4 and 10, with the Vermorel sprayer. He left no vines untreated for comparison; but the treatments were of no value as to the rot, three-fourths of the crop being destroyed by this disease, and they were apparently harmful to the foliage, as there was a "great failure of the leaves all through." Throughout the season the weather was "close, sultry, very hot and damp."

Mr. White experimented with the simple solution and eau celeste for grape rot on Nortons, but without any apparent benefit. "Grapes rotted with the solution visible on them." He commenced his applications June 5, following as near as possible the instructions given in the circular No. 3. "Weather wet and murky all summer."

The remedies used by Mr. Holliday were, first, a Bordeaux mixture containing 6 pounds sulphate of copper and 3 and 4 pounds of lime to 22 gallons of water. Second, eau celeste, with 2 pounds sulphate of copper, 3½ pints liquid ammonia to 44 gallons of water. The vines treated were chiefly Nortons and the area covered was about 10 acres. The amount of sulphate of copper used nearly 300 pounds. The amount of mixture to the acre about 88 gallons, the applications being made with a Lewis force-pump. He purchased his sulphate of copper at 5 cents per pound, lime at $1 per barrel, and ammonia at 70 cents per gallon, and his estimate of cost of preparing and applying the mixtures once is $1 per acre. The first application was made from the 9th to the 16th of June, the second (to a few vines only) about the 12th of July; but this was too late, Mr. Holliday states, to be of any use as far as rot was concerned, for there had already been two periods of attack of the disease.

First appearance of mildew June 1; of black-rot, June 8 on the Clinton, June 19 on the Nortons. In 1886 the loss of Nortons from black-rot is estimated at 33 per cent. The loss this year on the treated vines is 20 per cent., and on those not treated it is placed at 50 per cent. The foliage at the season of vintage was decidedly better on treated vines than on those not treated, and the wood appears to have ripened better. The test rows (untreated) in the section where eau celeste was applied showed the greatest difference in respect to rot. On the treated vines the loss was not more than 15 per cent., while on the untreated it was more than 50 per cent.

Mr. Holliday proposes to continue next season the use of sulphate of copper, and aim to make at least three applications.

Mr. Peter Frazier used the Bordeaux mixture on 225 vines, mostly Concords, making 2 applications, June 18 and July 5, respectively. Rot and mildew appeared June 9, the periods of rot being the 9th, 21st, and July 3. The remedy destroyed (prevented or checked) the mildew, but it had no effect against the rot.

Mr. Frazier is convinced that "constitutional weakness of the vine will invite the attack of black-rot." If growing large and juicy berries is a "constitutional weakness" this idea might be admitted, for such fruit is the kind which is most "susceptible" to the disease. But as I have said elsewhere, black-rot of grapes is purely the result of the attacks of a parasite, an organism with as positive characters as the vine itself, and the healthier and more vigorous the vine the more liberal and healthful will be the food supply to the parasite and the more it will increase and multiply. There are fungi which from their nature only attack the higher plants when they are in a weakened or enfeebled condition, but such is not the habit of either the downy mildew or the fungus of the black-rot.

Mr. Taylor experimented with the simple solution, eau celeste, and the Bordeaux mixture on Nortons, Ives, Clintons, and Concords, to the number of about 1,200 vines. The cost of material used was about $30 and the estimated cost of labor in making the applications $22. Two applications were made, beginning on the 28th of May, at which time the vines were in most excellent condition. At the time of the second application mildew and rot had both appeared. The greatest loss from rot was on the Clintons. The Nortons suffered early in the season from mildew, but the remedies seemed to stop it at once. The treatments were of no effect in checking the black-rot. The foliage on the treated vines in the latter part of the season was much better than on those not treated.

WEST VIRGINIA.

One report, from James F. Griffin, Nobe, Calhoun County, who writes that "from the 1st of May until about the 20th there was much rain, and black-rot commenced earlier than usual, and it was not until after this period that I made my first application, employing the simple solution of sulphate of copper, remedy No. 1. I made three applications, with an interval of about a week between each, and I believe I saved thereby one-third of my crop.

"On a few vines I applied sulphur and lime mixed, making the applications in the morning while the dew was on the foliage, with, I think, beneficial results, although I believe that the black-rot can be conquered by the proper application of the copper solution."

WISCONSIN.

Only one report from this State, made by Mr. A. S. Neff, of Woodstock, Richland County, which was simply to the effect that as there was no occasion to employ any of the remedies none were applied.

PART III.

TREATMENT OF THE DOWNY MILDEW IN FRANCE IN 1887.

TREATMENTS FOR MILDEW, IN FRANCE IN 1887.

[From a paper by B. Chauzit, Professor of Agriculture at Gard, in *Progrès Agricole et Viticole*, Nov. 6, 1887.]

The year 1887 was particularly favorable to Peronospora. From the beginning of spring traces of the disease were found here and there, but this attack was of little importance. In May and June it made a little progress, but only a few diseased leaves could be discovered in vineyards usually attacked by the mildew. But in July the Peronospora developed with an unusual rapidity and severity. The first attack showed itself about July 20, and the disease increased up to August 1. From this time, although continuing its ravages, it did not increase until a second attack occurred, about the 15th of August; at this time the mildew became doubly severe, and hindered the ripening of the fruit. The disease then seemed to be arrested, but a new attack, the most severe of all, made its appearance in the first part of September, lasting to the 10th of the same month. After this time north winds prevailed, the air remained dry, and the mildew ceased its attacks. But then the injury had been done; many of the leaves had disappeared, and the sugar had not been elaborated; the ripening of the berries was accordingly imperfect in many ways.

We have, then, in 1887, observed successive attacks of the Peronospora occurring between July 15 and September 10; and these attacks, all very severe, have appeared after rain-storms that were preceded by several days of damp winds. There fell during the period of the attacks (from July 15 to September 20) a column of water $203^{mm}.8$ high,* distributed in the following manner:

July (15 *to* 30).—$113^{mm}.8$ in six days of rain, 16, 17, 18, 19, 21, 30.

August (13 *to* 28).—47^{mm} in four days of rain, 13, 14, 23, 28.

September (4 *to* 10).—43^{mm} in two days of rain, 4, 7.

During the preceding months, that is to say, in April, May, and June, the quantity of water which fell was very slight, but it amounted to a total of 102^{mm}.

April.—$68^{mm}.8$ in five days of rain, 2, 3, 5, 6, 7.

May.—32^{mm} in six days of rain, 6, 7, 16, 17, 25, 26.

June.—1^{mm} in one day of rain, 27.

During the first days of April rain was very plentiful and the vine-growers began to be alarmed, and to say that the year of 1887 would be favorable to mildew. In fact, they already saw traces of the disease. Then the month of May, and especially of June, being very dry, they regained confidence, and some even considered it useless to treat the vines. They thought that the present year would be similar to the year 1886, and that the mildew would not show itself until very late, when it would not endanger the harvest. These optimistic prophecies were far from being realized. The year 1887 was, on the contrary, analogous to that of 1885, during which the mildew was very bad. Besides, as regards the amount of rain, the two years are similar, as figures show.

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* 1^{mm}, or millimeter, = $\frac{1}{25}$ inch.

In 1885 there fell during the months of May, June, July, and August 292^{mm} of water.

In 1887 the column of water was during the same time 222^{mm}.

In 1886 there fell during the same time only 92^{mm}.

It may be concluded that rainy years are the years of mildew. In South France it is not the heat which causes the absence of the fungus; the temperature is always sufficiently high to insure germination of the spores and fruiting of the mycelium. As to moisture, it is sometimes lacking, and then the disease is arrested. But when the year is rainy, the parasite finds around it the necessary conditions of development and grows rapidly. Consequently vine-growers ought to be doubly vigilant when rains are frequent during the summer season.

During the year 1887 the mildew seriously invaded the vineyards of Gard, and in two months it did considerable damage, completely defoliating the vines that were not treated and injuring those that had received the copper treatment. Moreover, it has been noticed that the degree of resistance of the different cultivated varieties was not the same in 1887 as in 1885 or in 1883. After the attacks of 1883 and 1885 we established the following scale of resistance, beginning with the variety most susceptible to the disease: Grenache, Carignan, Œillade, Jacquez, Aramon, and Petit-Bouschet. This year the order is changed, and the classification is as follows: Petit-Bouschet, Grenache, Carignan, Aramon, Œillade, and Jacquez.

It will be seen, then, that in 1887 the Petit-Bouschet suffered most; it lost its leaves during the month of August; nevertheless its grapes were gathered, on account of their early ripening. The Jacquez did very well during last season; the leaves from the ends of the shoots fell off, but the adult leaves, always very numerous, allowed the berries to ripen completely. This variety has nothing to fear from late invasions. It is rather in danger from early attacks, which, by arresting the development of the shoots, cause the fruit to fall off.

These general considerations upon the behavior of the mildew in the Gard being concluded, we will now examine and discuss the results furnished by comparative experiments.

For the purpose of placing a relative value upon the different remedies for the Peronospora, we organized a series of experiments. We chose eight lots of vines, situated in identical conditions, which we treated as follows:

Lot 1—900 vines.—*Simple solution of sulphate of copper* (½ kilogram * of the sulphate in 100 liters † of water. Strength of solution one-half per cent).

Lot 2—1,760 vines.—Eau celeste (½ kilogram sulphate of copper, one liter of ammonia, and 100 liters of water; strength ½ per cent).

Lot 3—1,590 vines.—*Ammoniure* (2 liters of concentrated ammoniure in 100 liters of water).

Lot 4—1,175 vines.—*Ordinary Bordeaux mixture* (6 kilograms of sulphate of copper in 100 liters of water, 8 kilograms of lime in 30 liters of water).

Lot 5—800 vines.—*Bordeaux mixture reduced* (1 kilogram of sulphate of copper, ½ kilogram of lime, 100 liters of water).

Lot 6—1,060 vines.—*Sulphatine* (composition, 10 per cent. of anhydrous sulphate of copper, 80 per cent. of sulphur, 10 per cent. of hydraulic lime).

Lot 7—800 vines.—*Barbusse powder* No. 1 (sulphate of copper 6 per cent., fat lime 94 per cent.).

Lot 8—1,200 vines.—*Cupric sulphosteatite* (10 per cent. of sulphate of copper).

We did not think it necessary to have check lots, as we used the neighboring vines for that purpose.

The surroundings were well chosen, for the vineyard in which we carried on our experiments is submerged in winter and irrigated in summer, and besides, it is situated in a country particularly exposed to the mildew. The variety cultivated is the Aramon; the vines are planted from 1.25 meters to 2 meters ‡ apart, and are old and vigorous. We made three applications; the first May 20, the second July 5, and the third August 4. The quantity of liquid mixture to the 1,000 vines was 60 liters (practically 13 gallons) at the first application, 85 liters (about 18½ gallons) at the second, and 120 liters (about 26 gallons) at the third. As to the powders, the proportions were less. At the first treatment we used 18 kilos to the 1,000 vines, 25 kilos at the second, and 35 kilos at the third.

The liquids and the Bordeaux mixture were distributed with a Japy pump, an instrument with which a man treated in eight hours 2 hectares § at the first application, 1½ hectares at the second, and 1 hectare only at the third, the leaf surface being greater. The work was thoroughly done, all the applications being made in my presence.

At the time of the first treatment we saw several spots of mildew on the leaves. At the second treatment, July 5, the disease had not ap-

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[*] 1 kilogram = 2.2 pounds.

[†] 1 liter = 1¾ pints.

[‡] One meter = 1$\frac{1}{10}$ yards = 3 feet 3⅜ inches.

[§] Hectare = practically 2½ acres.

peared in an alarming manner, but August 4, at the time of the third treatment, the disease was general and our experimental areas were seriously attacked. In August, September, and October we visited the treated lots and compared the results. Our result was as follows, giving the coefficient 10 to the lots free from mildew, and zero to those completely defoliated:

	Coefficient.
Ordinary Bordeaux mixture (No. 4)	8
Cupric sulphosteatite (No. 8)	7
Simple solution sulphate copper (No. 1)	6.5
Eau celeste (No. 2)	6
Bordeaux mixture reduced (No. 5)	3
Sulphatine (No. 6)	2
Barbusse powder (No. 7)	1
Ammoniure (No. 3)	1
Check lots	0

The Bordeaux mixture has, then, given the best results. The vines treated by the mixture lost but few leaves, the berries ripened well, and the foliage remained green.

The sulphosteatite, which is a mixture of talc (silicate of magnesia), inert matter, and sulphate of copper, also produced good effects. Being extremely light, it was uniformly spread by means of a good bellows.

The simple solutions of sulphate of copper were also very satisfactory, at the strength of ½ per cent. no leaves were burned even at the first treatment, and the lot thus treated ripened its crop very well. This remedy is very simple, but perhaps better results would be obtained by increasing the strength of the solution. We shall try this in our experiments next year.

Finally, the eau celeste, according to the last formula proposed by M. Audoynaud, that is to say, with the strength of ½ per cent., was insufficient; it is true that the lot which received this treatment was not destroyed by the disease, but the vines were partly defoliated and the grapes ripened imperfectly. As to the other remedies, our experiments condemn them. The Bordeaux mixture reduced, of a strength recommended by Millardet, only obtained the coefficient 3; and the powders with the copper base as well as the ammoniure did not hinder the rapid development of the disease. We could scarcely see any difference between the vines treated by them and those not treated at all.

We see, then, that four of the methods used are satisfactory, but in different degrees; they are the Bordeaux mixture, the cupric sulphosteatite, the solutions of copper, and eau celeste. By their proper use we are certain to save the harvest. However, these remedies may be improved. Eau celeste, especially, needs to be modified; it is necessary to increase the amount of copper, that is, to use it in a greater degree of concentration.

A résumé of these results are given below in tabular form. It is possible that they might have been different had the experiments been made in another part of the country.

Results obtained in the use of different remedies for mildew in 1887.

Remedies used.	No. vines treated.	Amount of material per 1,000 vines.			Coefficient: (10) No leaves attacked; (0) all leaves fallen.
		First treatment (May 20).	Second treatment (July 5).	Third treatment (Aug. 4).	
No. 1. Ordinary Bordeaux mixture .... 6 kilos sulphate of copper; 8 kilos lime; 130 liters water.	1,175	60 liters (13.2 gallons).	85 liters (18.7 gallons).	120 liters (26.4 gallons).	8
No. 2. Cupric sulphosteatite....... 10 kilos sulphate of copper; 90 kilos talc.	1,200	18 kilos (39.7 pounds).	25 kilos (55 pounds).	35 kilos (77 pounds).	7
No. 3. Simple solution of sulphate of copper: ½ kilo sulphate of copper; 100 liters water.	900	60 liters.......	85 liters.......	120 liters......	6½
No. 4. Eau celeste .... ½ kilo sulphate of copper; 1 liter ammonia; 100 liters water.	1,760	....do	....do	....do	6
No. 5. Bordeaux mixture reduced ..... 1 kilo sulphate of copper; ½ kilo lime; 100 liters water..	800	....do	....do	....do	3
No. 6. Sulphatine........................ 10 kilos sulphate of copper; 10 kilos hydraulic lime; 80 kilos sulphur.	1,060	18 kilos	25 kilos	35 kilos	2
No. 7. Ammoniure..........................	1,590	60 liters.......	85 liters.......	120 liters......	1
No. 8. Barbusse powder .... 6 kilos sulphate of copper; 94 kilos lime.	800	18 kilos	25 kilos	35 kilos	1
Check lots..................................	....	....	....	....	0

We will look now at what happens in working on a larger scale. Many vine growers have used treatments for the mildew this year. Some have used the Bordeaux mixture, others the eau celeste, and there are also some who have used powders with the copper base. Those who have used the Bordeaux mixture and eau celeste have had comparative success; those who have persisted in the use of powders have had badly diseased vines during the whole summer. As to the vine growers who have used no treatment, they have harvested green grapes, for the leaves, the organs which elaborate the sugar, disappeared early, These vines contrasted very strikingly with those which had been treated, they had a grayish appearance and did not grow; the others, on the contrary, were green and their fruit ripened properly. Another observation which we have made, is that the vines defoliated in August—put out new leaves at the end of September; on account of the cold of October these leaves could not become full grown, and the vine thus made an effort which was pure loss.

But all vine-growers who have treated their vines have not had the same results—some have suffered very much loss; either because the applications were made at the wrong time, or were not sufficiently numerous, or because they used too little liquid per hectare. It must not be forgotten that the remedy is only preventive, and that it is necessary that the copper should be upon the leaves before they are attacked; the paraiste is then destroyed in the beginning. If the applications are far apart, fresh attacks which will produce the disease upon the young leaves may occur in the time which elapses between two applications. Finally, if the application is not thorough, and the copper solution does not touch the whole vine, only those parts which have received the remedy are protected, and the vine suffers according to the amount of untreated surface. Consequently, if success has not been general and complete, it shows that the applications have not been regular, and that they have not been sufficiently numerous or thorough.

This year, in applications made upon a large scale, the Bordeaux mixture has given better satisfaction that the eau celeste. This is undoubtedly on account of the large proportion of copper contained in the mixture. But the eau celeste is, nevertheless, a remedy that will be used in the future. Its application is simple, its preparation easy, and its success sure. But it will be necessary to modify the formula. A strength of ½ per cent. will frequently prove unsatisfactory, and it will be better to use 1 per cent. In 1886 we used it at that strength, and could find no burned spots on the leaves. We will go still further, and say that the later treatments could be made with eau celeste containing 2 per cent. of sulphate of copper. At that time the leaf tissue is less sensitive than at the beginning of vegetation, and no accident is to be feared.

We know vine-growers who have applied solutions in which there was 2 per cent of sulphate of copper; this destroyed the mildew, and the leaves of the vine were not burned during July and August.

It has been reported to us that some one, having a small vineyard badly attacked by mildew, had the boldness to treat it with eau celeste containing more than 28 per cent. of sulphate of copper, and he has not complained of the results! We have also observed that the rows of vines treated with the solution in the bottom of the barrels which contained the eau celeste suffered much less from the mildew, the difference between these rows and the others being very noticeable. The bottoms of the barrels are always very rich in copper, since the eau celeste allows the metallic oxide to settle according as the ammonia escapes; all these facts show plainly that the eau celeste, even to a certain degree of concentration, is not dangerous to the vine, and that, in order to successfully combat the mildew, it is necessary to use a very large proportion of copper.

Consequently, if in 1887 the Bordeaux mixture has shown itself superior to the eau celeste, it is unquestionably on account of its large proportion of sulphate of copper. When we tried the Bordeaux mixture at 1 per cent., there was scarcely any result, while with eau celeste of the same strength the results were satisfactory; the eau celeste can then produce as good effects as the Bordeaux mixture with a less proportion of copper. The eau celeste is especially accused of burning the leaves—we shall see how much this is to be feared—and this inconvenience is not attributed to the copper, but to the bisulphate of ammonia which is formed. Since the sulphate of ammonia is the dangerous substance we should proceed to eliminate it, a process which may be very easily effected; we shall then have an absolutely harmless fluid.

The powders with the sulphate of copper base, excepting the sulphosteatite, have proved inefficient. In south France, where the wind is severe and dry, satisfactory results are never obtained from their application, especially when circumstances favor the development of the disease. Consequently, in spite of the numerous advantages offered by their employment—for sulphur can be added to them, and the mildew and oïdium combated at the same time—they must be condemned and their use abandoned. The sulphosteatite alone, which is very fine and contains the sulphate of copper in a very finely-pulverized condition, can be recommended. However, we ought to add that this powder, applied on a large scale, has given less satisfactory results than in our experiments.

Finally, we have observed, in visiting the vineyards which have been treated, that wherever the applications were poorly made—that is, made by inexperienced or careless workmen—the disease had continued its depredations. We should not advise the use of a broom, as it not only demands much manual labor, but does not sprinkle the vines thoroughly. With the spraying-machine the treatment is more even and efficacious.

In review, we believe we can draw the following conclusions from the preceding experiments and observations:

1. The sulphate of copper, employed in the simple solution, or the Bordeaux mixture, or the eau celeste, is an absolute remedy for the mildew.

2. In order to protect the vineyards from the effects of the peronospora, at least three treatments are necessary. The first application should be made between the 15th and 31st of May, the second between the 20th and 30th of June, and the third between the 1st and 15th of August. A fourth treatment, applied toward the end of September, after the grapes are gathered, will ensure the maturing of the shoots by by thwarting the attacks of mildew common at this season.

3. It is necessary to apply a large amount of sulphate of copper per hectare; we used 250 liters at the first application, 350 at the second, and 500 at the third.

4. The simple solutions of sulphate of copper should be employed at a strength of ½ per cent. for the first treatment, and 1 per cent. for the second and third treatments.

The eau celeste ought to contain 1 per cent. of sulphate of copper for the first treatment, and 2 per cent. for the second and third treatments.

As to the Bordeaux mixture, it is necessary that it should contain, in order to be efficacious, from 4 to 7 per cent. of sulphate of copper.

5. The powders with the copper base will not give good results except in countries where the dews are frequent and heavy.

6. Applications of sulphate of copper made by spraying-machines are inexpensive. For three applications the expense will be 2.50 francs for hand-work, and from 20 to 30 francs for material, according as the eau celeste or the Bordeaux mixture are used.

7. The eau celeste, which is a clear liquid, is more easily employed and more economical than the Bordeaux mixture, which clogs the instruments and demands a larger proportion of copper to produce the same effect.

8. The simple solutions of sulphate of copper not having been used except in our experiments, we can not advise their use upon a large scale. We shall wait for the results of our experiments next year before giving practical conclusions upon this process, which is simplicity itself.

Other things being equal, the untreated vines of Aramon have produced wines of 4° of alcohol, those poorly treated wines of 6°, and those well-treated wines of 8°. If the disease had appeared earlier the untreated vines would have lost their entire harvest.

For south France, and especially for the department of Gard, the effectual treatments of last season were doubly useful; they have saved a part of the harvest, and besides they have demonstrated to all the efficacy of copper treatment for mildew.

At present our confidence is great; peronospora does not frighten any one. But we anxiously ask if it is true, as has been said, that by the same process we can conquer the black-rot and coniothyrium, diseases which threaten vine-growing.

Experiments in the treatment of the downy mildew made by seventy-seven vineyardists of southeastern France (the region of the olive) in 1887. From "Progrès Agricole et Viticole," March 11, 1888.

Kind of remedy used.	Dates of application.	Dates of appearance of mildew.	Results and observations.
New Bordeaux mixture		August 1 to 5	Very satisfactory. Success with eau céleste in neighboring vineyards. Mildew especially felt upon Jacquez vines seven years old.
Bordeaux mixture	Before July rains	In July after rain-storms	Mildew appeared after rains. North wind, dry and cold, came in time to save the harvest. Brown rot present.
Eau céleste	After July rains		
Do	June 20, July 20	June 20	Excellent results. Coniothyrium (white rot) arrested by eau céleste.
New Bordeaux mixture	July	July	Mildew arrested.
Eau céleste	June 15, August 10 and 28	End of August; very severe	Very good results, and in this case liquids were preferred to powders.
Ammoniure mixture			
New Bordeaux mixture	June to July	In July, after rain-storms	Good. Thorough treatment. 15 hectoliters (1 hectoliter = about 22 gallons) of liquid per hectare (1 hectare = $2\frac{1}{2}$ acres).
Eau céleste	August 4	July 27	Disease effectually checked. No harvest from untreated vines.
Bordeaux mixture; eau céleste	End of May, July, August	May 23, July, August, September 6; severe attack	Good. A very strong dose of eau céleste made one lot proof against mildew.
Sulphosteatite			Good.
Sulphatine			Medium.
Eau céleste	July	August	Good. The disease revived after the grapes were gathered.
Skawinski's powder	May, June, etc	June	Perfectly successful.
Eau céleste	July 10	September 20; after harvest	Good. Some traces of mildew after the harvest.
Do	10 days after the attack	August	Disease arrested.
Bordeaux mixture	End of May, end of June, end of July.	End of July, end of August	Very good.
Eau céleste	End of June, August	August 1 to 15	Good.
Do	End of May, August 15	End of July, September 15	Good. The black rot destroyed a quarter of the crop from 2 hectares of Morastels.
Do	June 15, August 10	June, August	Very satisfactory. Nursery of Jacquez well preserved by treatment with eau céleste.
Different powders	Different dates		Medium.
Eau céleste	May 15, July 1, July 10	July 10	No result.
New Bordeaux mixture	End of July, August 1		Good.
Sulphosteatite	do		Medium.
Eau céleste	End of May, end of June, end of July, August 15, September 10.	July 17, after rain-storms	Satisfactory.
Sulphatine	June to July	August 15	Medium.
Eau céleste	June 5, end of June, July 25	End of June, July, August 15, September 1 to 10.	Complete success.
Do	May 15, end of June	June 1 to 10, September 10	Very satisfactory. Petit-bouschet severely tested.
Do	June 7, June 21	June 20, July 25; severe attack.	Remarkable success. June 22, strong northwest wind (*mistral*), also July 25. Carignans badly attacked treated in July and August.
Bordeaux mixture	Three treatments	May 10, end of June, July 15 to 30	Complete success.
Very concentrated eau céleste	Several treatments from May 30 to August 18.	End of May, July 15, August 15 to 30.	Excellent. July 22, Coniothyrium, good effects of eau céleste increased. Caterpillars, plant lice, erineum and other insects checked by eau céleste.
Bordeaux mixture			Excellent.
New Bordeaux mixture	June 4	June 20, July, August	Good. Crop perfectly ripened.
Eau céleste	July 22	After rain-storms	Good.

Experiments in the treatment of the downy mildew made by seventy-seven vineyardists of southeastern France, etc.—Continued.

Kind of remedy used.	Dates of application.	Dates of appearance of mildew.	Results and observations.
Eau céleste	May 20, June 20, July 20	July 20	Very good. One lot treated but once after July 20 suffered from mildew.
Do	June 15, July 15	July, August	Good.
Do	July	End of June	Very satisfactory.
Ammoniure mixture	June 3	June 30	Applications superposed; vines saved.
Bordeaux mixture	July 1		
Eau céleste	August 1		
Do	June 24, end of July	End of July	Good. Coniothyrium checked.
Bourguignone solution		End of August	Good.
Eau céleste	June 15, July 25	End of July	Perfect.
Sulphatine			Medium.
Eau céleste	May, July	do	Not very satisfactory.
Do	do		Good. Light attack toward the end of September.
Do	End of May, June, and August	July 25	Excellent. Foliage preserved until December.
Do	August	August	Good. A little mildew in August.
Do	End of May, end of July	End of June, end of July	Very satisfactory.
Do	June 2, July 22, August 6	July 24, August 5	Satisfactory.
Do	June 15, August 15	End of May	Very satisfactory. Sulphur sulphate, used when the leaves were wet with dew, caused severe injury.
Do	May 10, July 15	Middle of July	Excellent. In my case not a leaf has fallen even from the Carignans. The wine made from young vines that were submerged weighed 8° 5.
Do	End of June	June 28	Good. Attack slight.
Do	June, August	September	Good. Attack slight. Untreated vines lost their leaves in September; treated vines kept their leaves.
Do	April, June	End of September	Good.
Do	End of May, August 1	July 8, September 8	Satisfactory. Leaves did not fall until very late.
Do	June 20	June 15, September	Excellent. No results from some treated with sulphur sulphate.
Do	May 20, July 15, August 8	July 10	Good. Slight burns upon the edges of the leaves, May 20.
Do	July 18, August	July 15	Excellent. Leaves preserved until the first frost.
Do	August 1	August 1 to 15	Good upon Jacquez and Othellos. Medium upon Grenaches.
Copper Sulphate 3 per cent		August 6, September 4	Results not very marked.
Bordeaux mixture	May, June	June 1 to 15, September	Satisfactory. A nursery of Jacquez badly injured in spite of two treatments.
Eau céleste	June 1 to 5, August 1 to 5	August 1, September 1	Very good upon Jacquez with two applications. No result upon French vines that had not received the August treatment.
Do	May, June, July	June	Moderate success upon Grenaches. No result from powders.
Do	July 15, August 1	End of September	Amount of success not established on account of the late appearance of mildew.
Do	June 15, July 10 to all August 12 on one portion	July 15, August 10	Good success with three applications. Medium with two treatments; some burns.
Do	June 20, July 20	August 5	Treatments superposed.
Bordeaux mixture	August 8	Very severe	
Eau céleste	July 15, September	July 15, August 31	Satisfactory. Attack very sudden and severe.

Lime, sulphur, sulphate of copper			Satisfactory as compared with neighboring vineyards that were untreated.
Eau céleste and powders	At dates of attacks	June 6	Good.
Eau céleste alone		July 30, September 1	
Copper sulphate solution	June 5	End of July	Very good.
Eau céleste	End of May, end of July	End of August, September 15	Good.
Do	July 1, August	End of June	Good. Leaves preserved until frost.
Do	June 5, August 1, August 26	May 28, June, July 28, August; severe attack September 8.	Perfectly satisfactory. Some burns in June; leaves preserved until frost.
Do	June 15, August 15	September 10	Good. Some burns from working after sunset. In the neighboring vineyards that were not treated the crop was much injured. Potatoes and tomatoes were also benefited.
Do	May 15, end of June	August 1 to 5; slight attack	Very good. In August the black rot destroyed the crop. I regret that I did not combat this by a third application.
Do	Two and three applications	August 1 to 5, September	Complete success. After three treatments black rot destroyed from 15 to 20 per cent. of the crop of the treated vines and 95 per cent. of those untreated. One farmer very seriously asserts that in 1886 mildew attacked ash trees.
Bordeaux mixture	July 10	July 13	Results good, but the applications superposed. Reappeared upon the young shoots in August.
Eau céleste	End of July		
Bordeaux mixture	May 1, end of July	End of June, July, September	Treatments superposed; good harvest.
Sulphosteatite			
Sulphur sulphate			
Eau céleste	August 1	End of July	Excellent.
Do	July 1 to 15	July 1 to 15	Good.
New Bordeaux mixture	July 15	August 15	Good.
Bordeaux mixture	July 22	July 19	Good. Disease arrested by a northwest wind.
Eau céleste	July 8, August 15	July 8	Excellent.
Do	Upon 6 hectares at the end of June.	June 1 to 10	Excellent upon the 6 hectares.
Do	Upon 100 hectares, end of July	July 26; general attack	No results for those that had only one treatment after the attack. Coniothyrium arrested by eau céleste, and it also seemed to act upon anthracnose.
Bordeaux mixture	July 20, August 20	July 20	Good results in vineyards treated in June and August by eau céleste only.
Eau céleste			
Do	June 1, end of June and July	July 20, August	Very satisfactory.
Do	July 23, August 9	August 1 to 15	Very good.
90 liters of lime-water and 600 grammes copper sulphate in 10 liters of water.	May 15, June 15, July 15	June 12, end of August	Good.
Eau céleste	May 15, June 15, July 18	May 15, June 15, September 3	Good.
Do	May 10, June 12, July 10	May 28, June, August 17	Good.
Ammoniure			Good.
Sulphosteatite			Medium.

SUPPLEMENT.

APPARATUS FOR COMBATING THE MILDEW AND OTHER FUNGUS DISEASES OF PLANTS.

COMMUNICATED BY PAUL FERROUILLAT,

Professor of Rural Engineering at the National School of Agriculture,
Montpellier, France.

APPARATUS FOR APPLYING LIQUIDS AND POWDERS TO VINES IN THE TREATMENT OF FUNGUS DISEASES.

At the outset, in arranging for experiments with the various remedies proposed for combating the mildew and rot, it was necessary to consider the means for applying them. The results depend largely upon the manner in which these applications are made, and it was therefore necessary to procure a good bellows, which would, without too much fatigue, distribute the powders evenly, and a spraying-pump, which could be conveniently carried through the vineyards, and by which the liquids could be thrown upon the foliage in the form of a fine mist, rapidly and economically. All appliances obtainable from American manufacturers were objectionable in one or more particulars, especially in the labor involved in operating them and in the nozzles with which they were supplied. The latter distributed the liquids in a shower rather than spray, unnecessarily *drenching* the vines and wasting the material used; those giving a fine spray with clear liquids at once became clogged when one attempted to use a thick liquid like the Bordeaux mixture. Pumps giving an intermittent jet, or those used with buckets containing the fluids, which had to be set down at each vine during the spraying of the latter, were wholly out of the question. In view of this state of affairs at home we looked abroad for the appliances which had been invented to meet just such requirements as our contemplated experiments demanded. In France, where the remedies we were going to try had been in use for two years, a number of spraying-pumps had been devised which, from the illustrations and accounts given, appeared to be far superior to anything we possessed, and it was decided to import the Vermorel spraying-machine (Fig. 12, p. 100) and the Lagleyze bellows (Fig. 2, p. 93). Two models of the former were received, one having the pump separate from the reservoir and carried in the hands, being operated like a syringe but giving a continuous jet, the other having the pump attached to the reservoir and operated by a lever. The latter style, by far the most satisfactory, is illustrated on page 100. This pump was used at the station in New Jersey. The other pattern was employed at the stations in Virginia, Missouri, and Texas.

This importation has led to a demand for similar machines here, and one has been constructed by Adam Weaber, under the supervision of Col. Alex. W. Pearson, which is superior in some respects to the Vermorel. The entire apparatus is somewhat heavier, but the power of the pump is much greater, being sufficient to spray trees of moderate height, and it is said to be far more durable in construction. The pump may be detached from the reservoir, and all its parts are accessible and easily kept in order. With this machine one man can spray 4 to 6 acres per day. It is named the Eureka Sprayer.

The Lagleyze bellows was not received in time to be used in our experiments, else better results might have been obtained in the trials made with powders. These bellows are illustrated on page 93, and in simplicity, ease of operation, and evenness with which the powders are distributed they leave little to be desired.

The necessity in this country for good spraying-pumps and bellows for vineyard use in applying the various preparations having sulphate of copper for a base is particularly evident in the reports of correspondents who experimented with these compounds last summer. Many had to resort to brooms or to ordinary sprinkling-pots, or to what was scarcely better, some of the garden syringes which our markets afford. There appears also to be a lack of information as to the requirements in the case and as to what really constitutes a good instrument. In order to meet this apparent want the following chapter on "Apparatus for Combating the Mildew," kindly prepared for this Section by M. Paul Ferrouillat, professor of rural engineering at Montpellier, France, a gentleman who has given this subject special study, is here presented. It is hoped, also, that this chapter may incite our manufacturers to the production of even better appliances than are here described. These points should be kept in mind—*simplicity of construction*, *ease of operation*, *economy of material used, and cost.*

F. L. S.

APPARATUS FOR COMBATING MILDEW.

By P. Ferrouillat.

Scarcely three years ago the only instruments known for the purpose of scattering powders upon plants attacked by parasitic diseases were simple sulphuring boxes and a few forms of bellows, invented to combat the oïdium. As to appliances for properly distributing liquids over plants, there were practically none until the present epoch. In greenhouses only, spraying instruments, such as are still in use in rooms, were used either to sprinkle the leaves and flowers or to throw poisonous fluids upon plants for the purpose of clearing them of insects and cryptograms. The employment of spraying machines was very limited, and such as were in use were impractical for extended areas. Difficult to operate and working slowly they could be used only under the conditions we have just indicated, to preserve rare and delicate plants.

In 1884, the introduction into France of the Riley nozzle greatly altered the methods formerly used for spraying liquids. This nozzle was certainly remarkable both for its simplicity and efficacy, and it was soon widely known and substituted for those hitherto employed.

The demonstration of the efficacy of salts of copper in the treatment of mildew has been the starting point for numerous inventions. In less than a year we have seen many instruments produced for applying these various solutions. Instruments for throwing powders have also been perfected, but it is especially those for spraying liquids in which progress has been most evident.

There are, then, two classes of instruments for combating mildew, one for scattering the different powders with a sulphate of copper base, and the other for distributing either clear or more or less thickened liquids over the surface of the leaves.

The first ought to act in such a manner that the powders may be entirely spread upon all the green parts of the vine. Each particle of sulphur exerts an action upon the mildew; the instrument should therefore project the powder in the form of a fine cloud, in such a way that several grains shall not fall upon the same place, but so that all parts of the plant may be completely covered. Moreover, this should be rapidly done. The apparatus employed ought to be easy to manage, so as not to fatigue the workmen who use it; and, so far as possible, it should work so that they need not continually stand in a corrosive cloud of powder, a prolonged contact with which may be injurious. Finally, it is necessary that the instruments should be durable and inexpensive.

The second can be divided into two classes; those which throw the liquid so as to sprinkle the leaves and cover them more or less thickly with drops of varying size, and those which resolve the liquids into a spray, so as to envelope the entire vine in a fine mist. Both ought to admit of rapid work, with but little trouble to the laborers, and should be solidly constructed.

I. BELLOWS WITH EXTERNAL RESERVOIR.

With these instruments a current of air, produced by a bellows, is used to project the powder for some distance in front of the operator. The mixture of air and the pulverized material aids in its diffusion, and ensures as even a distribution as possible.

Simple bellows, in which the powder is in direct contact with the leather, are out of the question for treating mildew. The leather would soon become rotten, and the bellows become leaky. It is indispensable that the powder be isolated by placing it in a box which is independent of the bellows, although attached to them.

(*A*) *Malbec bellows.*—This apparatus, represented in Fig. 1, is composed of an ordinary bellows, to one side of which is attached a powder reservoir. The bellows and reservoir communicate by an opening between them. The powder-box is divided by a horizontal perforated plate for the purpose of sifting the powder, which occupies the upper portion. It also hinders the coarser grains from passing into the lower part, where they would be practically lost by being thrown out entire over the surface of the vine. A blast-pipe begins in the box. When the bellows are worked the air passes directly into the box, and from there into the blast-pipe, taking with it a certain quantity of the powder. A valve hinders the powder from being drawn back into the bellows during the inspiration. Price, 4 francs.

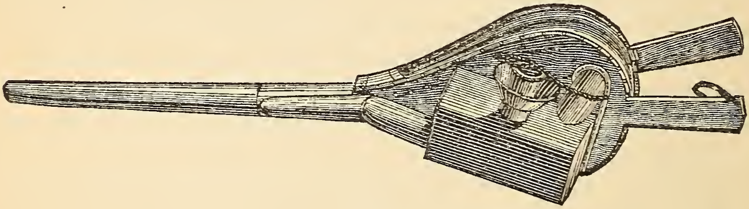


FIG. 1.

(*B*) *Lagleyze bellows.*—This is the most perfect and at the same time the most simple of the instruments having an independent box. It is composed of a bellows (S. Fig. 2) which throws a current of air into the powder-box R, and from there into the blast-pipe T. The box R, which is in the form of a truncated cone, is attached to one side of the bellows. Within, a perforated plate sifts the powder. An agitator, D, crushes the lumps, mixes the powder, and causes it to be sifted regularly. The agitator is borne upon a pivot, which is attached at *b* to the crank *c;* this crank is attached at *a* with an iron-plate, which is screwed upon the side of the bellows opposite the box. The tube C joins the lower portion of the bellows with the blast-pipe at A. The blast-pipe is terminated by a curved fan or deflector, B, which serves to direct the blast.

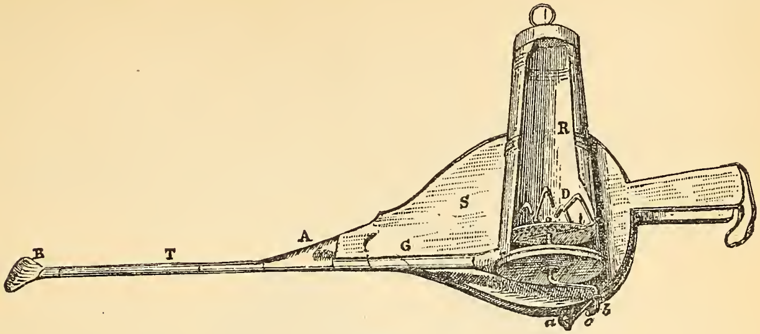


Fig. 2.

The instrument is light and inexpensive (5 francs), and is easy to work.

(*C*) *Pinsard apparatus.*—This machine, represented in Fig. 3, is composed of a tin reservoir, A B C D, containing from 12 to 15 kilos of powder. It can be fastened upon the back of the operator by the strap L, which is attached to the buckles M M′.

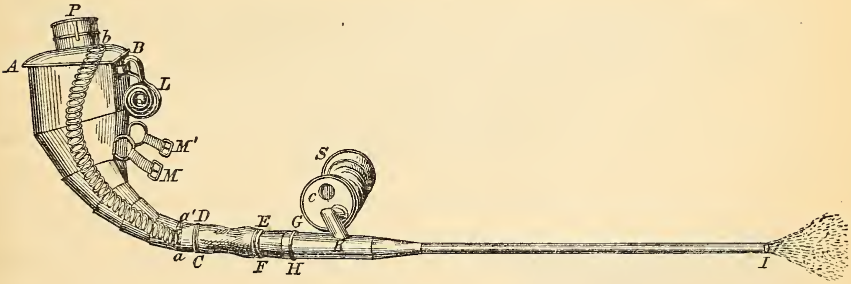


Fig. 3.

Within there is a long coiled spring, attached at *a*, *a′*, and *b*, which vibrates with the slightest motion of the operator. The undulations and vibrations constantly stir up the powder, and carry it into the lower part of a box. A large leather pipe, C D E F, unites the box with the blast-pipe G H I, into which a current of air can be directed by the aid of the bellows *s*, which communicates with it at K. In order to use this instrument, the workman who carries it holds the tube E F G H in his right hand, and works the bellows with the left. At each step he rapidly raises and lowers the blast-tube, and presses the bellows at the same time. These movements of the blast-tube transmitted to the spring cause the powder to fall into the opening of the tube, while the blasts from the bellows force it out in the form of a cloud more or less fine. The apparatus costs 15 francs.

This instrument works evenly when in the hands of practiced workmen. It has the advantage of not requiring frequent filling. One may, perhaps, by its use sensibly economize labor and time.

II. Fan Bellows.

There are only two instruments of this kind that deserve mention.

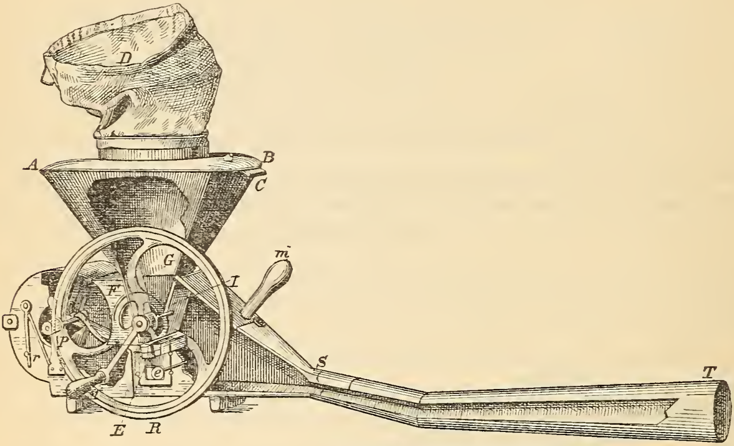


Fig. 4.—Gendre Machine.

They are composed of a box or hopper, containing a certain quantity of powder. A distributor moves in the bottom and feeds the blast-pipe. In this blast-pipe a current of air is produced by a fan placed in the rear of the machine. The powder is forced out of the tube by the blast from the fan, and emerges in the form of a cloud, more or less fine.

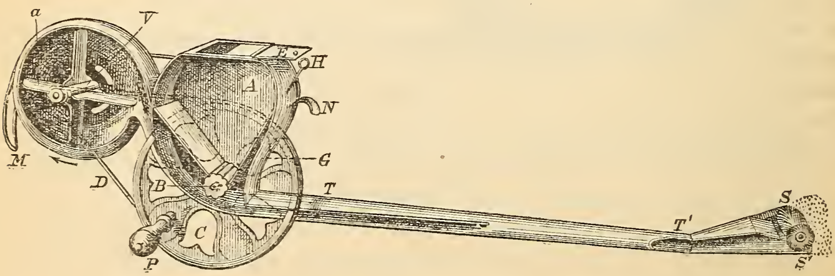


Fig. 5.—Trazy Machine,

The instrument is fastened to the belt of the operator, who directs it with the left hand and works the fan with the right. The price of the Trazy machine, Fig. 5, is 12 francs; that of the Gendre machine, Fig. 4, 25 francs.

III. PROJECTORS.

The only projector worthy of attention is made by the Japy Brothers, under the name of the "*Chauleuse centrifuge.*"

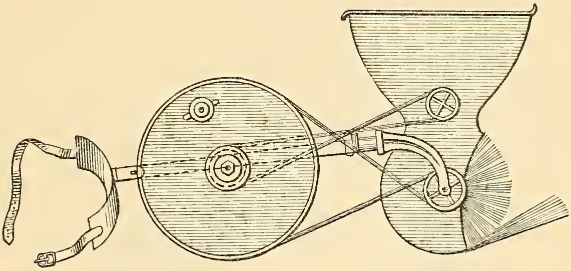


FIG. 6.

This projector (Fig. 6) is composed of a circular broom turning in a sort of drum, open in front. Above is a hopper in which the powder is placed. An agitator acts at the same time to facilitate the descent of the powder, and to pass it from the hopper into the drum where the broom works. These arrangements are fastened to a long arm joined to a belt, which the operator can fasten around him. Motion is imparted to the agitator and broom by two bands which pass over wheel pullies.

The operator holds the instrument in his left hand, while with the right he turns a crank fixed to the commanding pulley. The powder, carried along by the rapid movement of the broom, is projected violently.

The price of the machine is 14 francs. A very simple alteration will change it into an instrument that can be used for spraying liquids.

IV. SPRAYING MACHINES.

Spraying machines are for the purpose of spreading liquids by reducing them to a perfect state of division, so that they come in contact with the plants as a very fine mist or in form of a cloud. It is easily seen that when the division reaches its maximum the use of large quantities of liquids will be unnecessary, and at the same time we are sure that they will touch all parts of the leaf surface.

These machines comprise, (1) a reservoir for the liquid; (2) a spraying nozzle; (3) a pump or any compressing apparatus for transmitting to the liquid, either directly or through the elasticity of the air, the pressure necessary to force it through the spraying nozzle for the purpose of division. These parts are generally of copper, so as to better resist the corrosive action of copper sulphate.

The liquid reservoirs are circular or elliptical in section, and are generally carried on the back like a knapsack. In order that the fatigue to the operator may be as little as possible, it is necessary that the reservoir should be broad and thin, so as to occupy as much space as possible on the shoulders. Under these conditions the weight of the reservoir and the contained liquid, acts at the end of a very short lever arm. If the apparatus is intended for thick liquids, it must contain a mixer or agitator in order to preserve a homogenous composition throughout the operation.

The nozzle, the parts that effect the division of the liquid, are nearly all made according to four types.

The first type comprises those in which the division of the liquid is effected by a mixture of air and fluid under pressure. They are not apt to become clogged, and work satisfactorily with thick liquids. They are simple and easily kept in repair. But they do not give a sufficiently fine division of the liquid. Besides, the spray formed is not sufficiently fine or extended.

To the second group belong all the apparatus constructed on the principle of the Riley nozzle. This nozzle, represented in plan and elevation by Fig. 7, is composed of a cylindrical copper or brass box closed above by the cap B, made of the same metal. A rubber tube carries the liquid from the receptacle D, and passes it into the nozzle chamber by the orifice A, which opens tangentially to the inside. At the center of the cap there is an opening from 1 to 2 millimeters in diameter; it is cylindrical below, but spreads out into the form of a funnel, F.

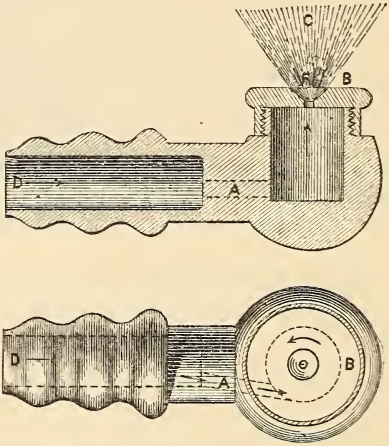


Fig. 7.

The liquid conducted under pressure into the interior of the box, revolves rapidly in the direction indicated by the arrows, and passes out through the opening in the cap, forming a sort of revolving cone whose sides become transformed into a fine spray.

This apparatus is simple and easy to keep in order. It works perfectly with clear liquids. For spraying thick liquids the central orifice of the cap should be from 2 to 3 millimeters in diameter, and it is desirable that it have a " degorger " or cleaner (described below).

To the third type belongs the apparatus in which a spray is produced by bringing the liquid, under pressure, through a small orifice, obliquely in contact with a small metal plate in shape of a fan; or by directing it against the lateral surface of a metallic cone, whose apex is directed towards the orifice. The stream, upon meeting the resistance of the metal, is broken up and spread out into a fine mist in shape of a fan or conical sheet, according to the apparatus used to break the jet.

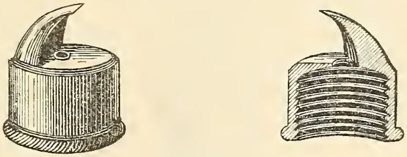


FIG 8.

This style of nozzle belongs to the type known as the *Raveneau.* It is composed simply of a screw cap (Fig. 8) with a small orifice, in front of which is obliquely placed a slightly concave metal plate. The liquid, coming in contact with the plate, spreads out into a sheet whose edges separate into a fine spray.

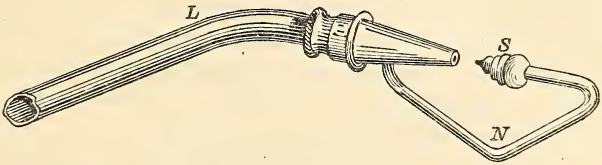


FIG. 9.

In the other case, a tube, L, is terminated by an adjustment with a small orifice. A brass rod is fastened near the orifice; the rod is bent twice, N, and a metal cone, S, with its apex turned toward the aperture, is screwed to the end. The stream, forced out of the tube, breaks forcibly against the sides of the cone and spreads out into a fine, cone-shaped spray, the size of which depends upon the distance between the end of the tube and the metal cone. Finally, a spray may be obtained by breaking two jets of liquid against each other at a definite angle.

This is the arrangement adopted in the Japy nozzle (Fig. 10). This nozzle ought to give excellent results, and it can be used with a number of machines.

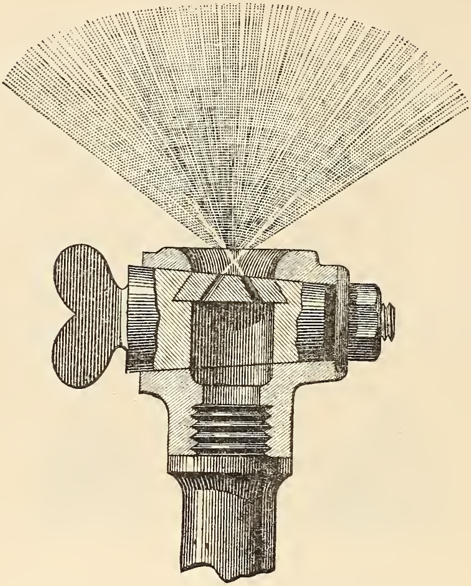


Fig. 10.

All spraying machines, of whatever style, ought to spread the liquid over the upper side of the leaves. With them one should be able to treat, at each trip between two rows of vines, either one, two, or several rows, according to the form of the nozzle used, the power of the pump, and the methods adopted in planting and training the vines.

Pumps with direct pressure upon liquids are generally more simple, easier to keep in order, and less delicate than the air-pump. But their parts are destroyed very rapidly by contact with sulphate of copper and eau celeste. The metallic parts become oxydized, the valves injured and repairs are soon necessary.

Before arriving at the nozzle, the liquid always passes through an air-chamber, which regulates the outflow and keeps the supply constant.

The air pumps are more delicate and demand more careful construction than pumps for direct pressure upon liquids, for all leakage must be avoided both around the circumference of the piston and at the valves. The packing ought to be perfect and well cared for. Not being in contact with liquid the metal of these pumps is less liable to be oxidized. The reservoirs ought to be absolutely tight, and to have their sides sufficiently thick to resist the internal pressure to which they are subjected. The operation of air pumps is generally less laborious than in the case of liquid pumps, because the work may be intermittent.

(*A*) *Apparatus on wheels.*—When apparatus was first constructed for mildew treatment, the first natural consideration was how the liquids and pumps should be transported in the vineyards.

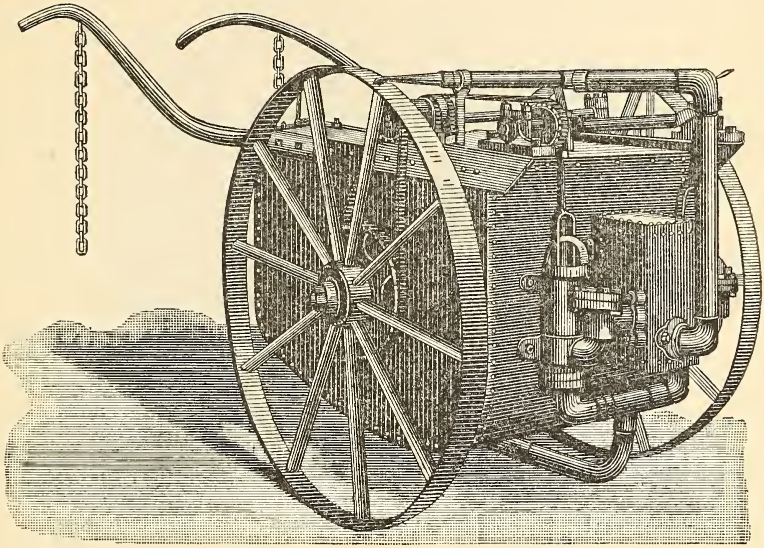


FIG. 11.

The *Bosc apparatus*, designed to be drawn by horses (Fig. 11), is composed of a reservoir provided with an agitator. The axle of one of the wheels drives a suction and force pump by means of a *Vaucanson* chain; this throws the liquid over several rows of vines at the same time. But this apparatus demands the inconvenience of taking a vehicle into the vineyard, which is very difficult after vegetation has reached an advanced stage of development, even where the vines are planted far apart. Moreover, it generally draws very hard. Consequently we have generally substituted spraying machines with portable reservoirs, which are the only kind that can be used in all stages of vegetation and with any method of training the vine.

(*B*) PORTABLE APPARATUS.—(a) *Vermorel machine.*—This apparatus is one of the best, having direct pressure upon the liquid. Its inventor calls it "*L'Eclair.*" It is composed (Fig. 12) of a reservor, either of red copper or sheet lead (for eau celeste) of a flattened form, containing from 12 to 15 kilos of liquid, and when empty weighs 5 kilos. The pump is joined to the reservoir, being placed upon the bottom. It is worked by means of a horizontal lever below and at the right, which the operator alternately raises and lowers. The pump does not have a piston, this being replaced by a circular rubber diaphragm, which is made concave or convex by the movements of the lever and thus regulates the suction or expulsion of the liquids in the reservoir. The apparatus contains an air chamber which insures a continuous delivery. The delivery tube is below and to the left of the reservoir; a rubber tube unites it with the lance, upon which is a modified Riley nozzle, with an automatic degorger (Fig. 13).

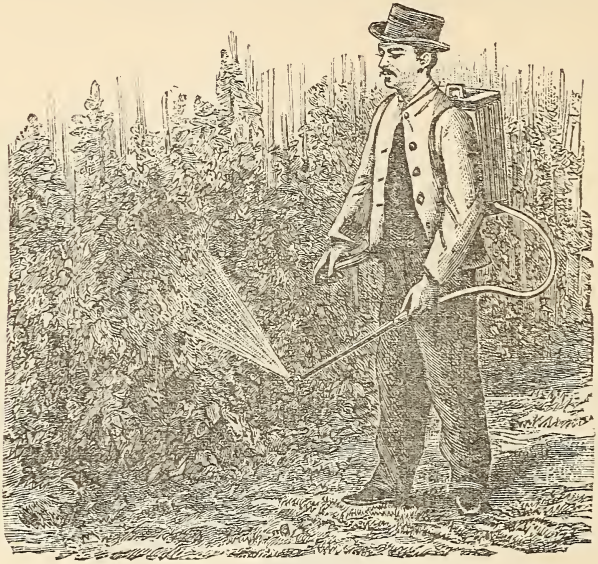


Fig. 12.

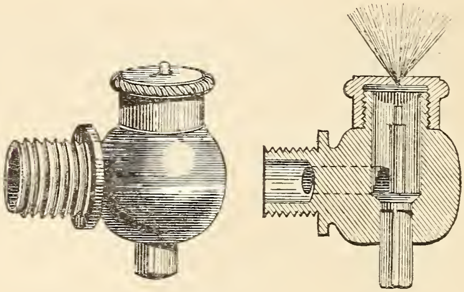
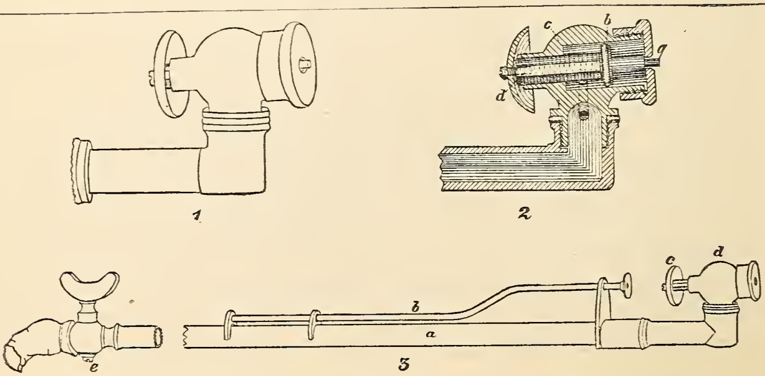


Fig. 13.

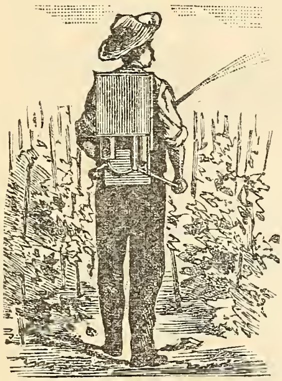


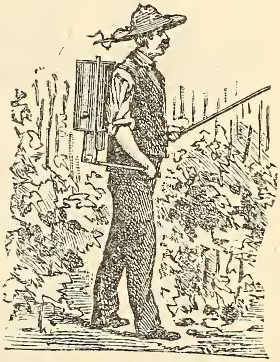
The Vermorel nozzle and lance used by the Section of Vegetable Pathology.

The chamber of the nozzle is pierced at its base by an orifice from 5 to 6 millimeters in diameter, which is closed by a valve. This carries a needle directrix, which, when the valve is raised, penetrates into the orifice of the cap. At the same time the lower orifice is opened. When, on the contrary, the valve closes the lower orifice, that in the cap is opened, allowing the passage of the liquid.

The manner of operating the degorger when the nozzle becomes clogged is simple. The operator has only to raise the valve with his finger, the needle penetrates the orifice in the cap and clears away the material that clogs it, while the liquid, escaping by the large lower orifice, carries with it any deposits formed in the chamber. As soon as the finger is withdrawn the pressure of the liquid closes the valve and opens the orifice in the cap.

A hectare (2½ acres) can easily be treated per day with 400 liters of liquid. Price of complete apparatus, 40 francs.





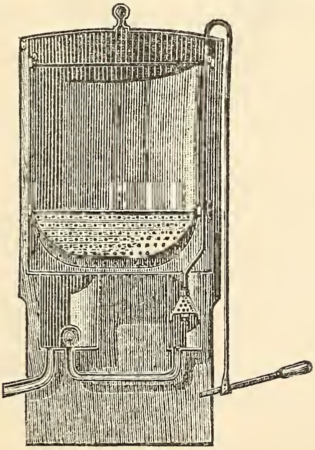


FIG. 14.

(*b*) *Vigouroux spraying machine.*—Consists of a very flat reservoir of yellow copper (Fig. 14), which will hold 12 liters of liquid. This reservoir, widely open above, is provided with a double cover in order to prevent the escape of liquid during transportation. The pump is placed under the reservoir on the right and in direct communication with it. In the pump is a piston of the Letestu system, worked by a rod which traverses the entire length of the reservoir, passes through a hole in a cover, is bent back upon itself, and attached to a working lever whose fulcrum is fixed under the reservoir. Within the reservior the rod moves an agitator.

To the lower part of the pump is fitted a tube which opens at the bottom of an air chamber placed in left side of the apparatus. The delivery tube, which unites the reservoir with the nozzle, begins in the bottom of this air chamber.

The nozzle is a Riley with a degorger, which is a pin placed in the axis of the nozzle and held at the bottom of the chamber by a coiled spring; by pressing upon the free end of the lever represented in figure 15, the pin penetrates the spraying orifice, closing and clearing it at the same time. Instead of the Riley, a Ravenau nozzle may be screwed on the lance.

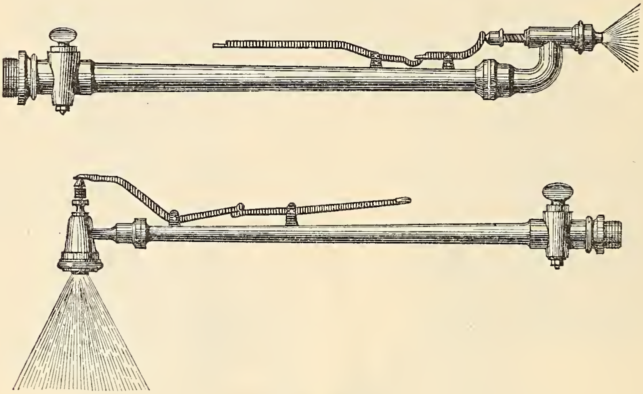


FIG. 15.

The apparatus being full of liquid, the workman gives the piston several strokes with his right hand so as to compress the air in the chamber, then he opens the stop-cock in the lance and the liquid is forced through the nozzle. The operator can work the lever at regular intervals without haste. He walks between the rows of vines, without stopping, at the rate of about three kilometers per hour, and can thus treat 2 to 3 hectares per day. The spray is fine and even.

Price of apparatus, 40 francs without agitator; 45 francs with agitator.

(c) *Japy machine.*—Two years ago the Japy Brothers constructed two spraying-machines with portable reservoirs. The first has only one pump; but the second was made for work on a large scale and provided with two.

The apparatus itself much resembles that of the Vigouroux. It also (Fig. 16) consists of a reservoir of copper or sheet lead, with a Letestu pump and an air-chamber. The pump is worked by a lever below the machine and at the left of the operator; or, sometimes, by a lever like that of a forge-bellows above and at the left of the machine.

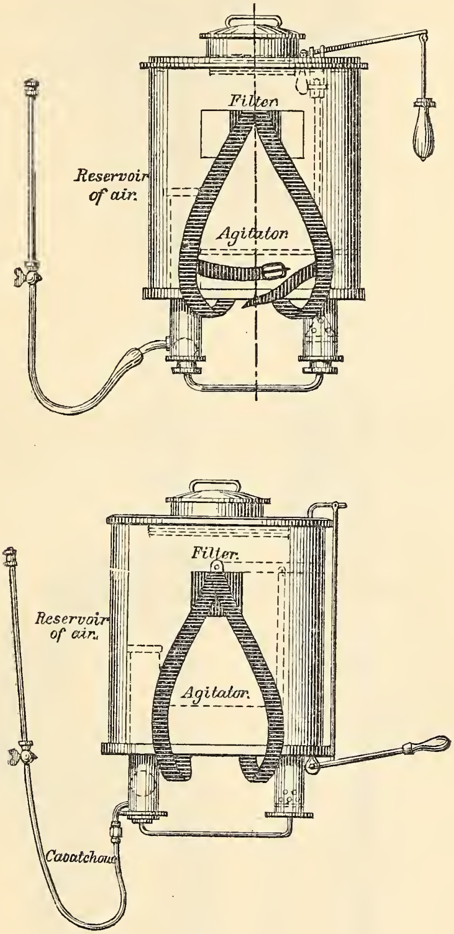


Fig. 16.

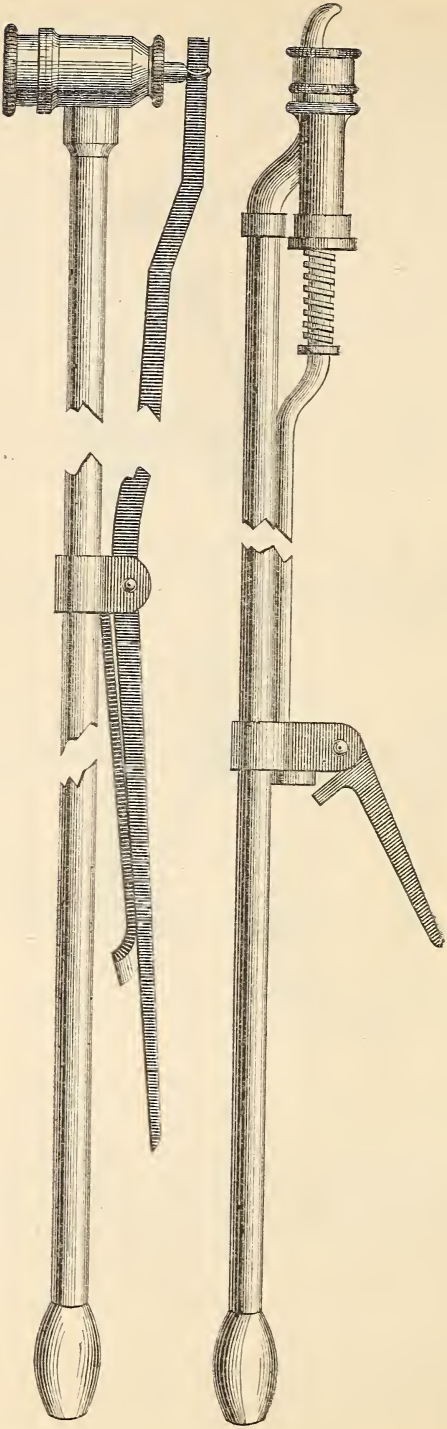


Fig. 17.

The spray may be produced either with a Riley or Raveneau nozzle, either one having a degorger (Fig. 17); sometimes a Japy nozzle with a stop-cock is used. (Fig. 10, p. 98, shows the nozzle at work.) Fig. 18 represents the same nozzle with the stop-cock turned around for the purpose of clearing it. It is plain that when the orifices are clogged it will be sufficient to reverse the cock, so that the liquid, by flowing in an opposite direction through the orifices, will force out the obstruction. If the stop-cock is turned only a quarter around, it closes the lance.

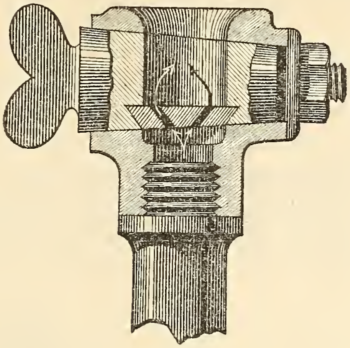


Fig. 18.

The machine for work on a large scale (Fig. 19) is composed of a reservoir and two Letestu pumps. With this the liquid is forced into an air-chamber, a valved box, from which it escapes by a tube. The tube passes over the back of the box, turns forward over the top, passes over

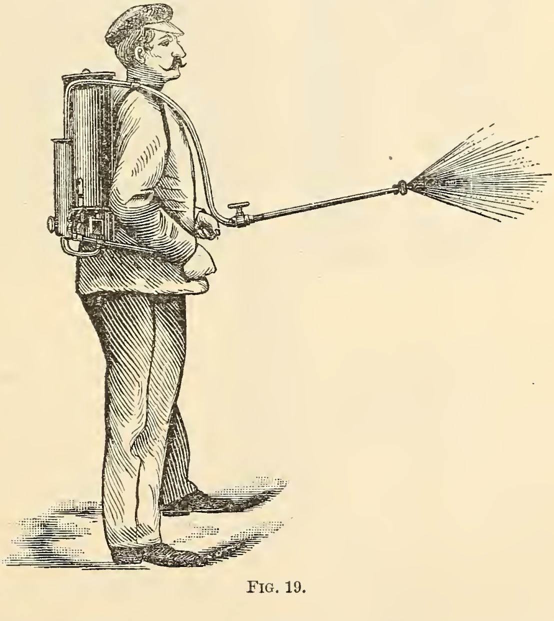


Fig. 19.

the workman's shoulder, and its free end is directed forward by a double curve. On the end is screwed a lance, bearing a nozzle. The workman places his hands upon the two levers, which are at about the level of the hips, and their motion is transmitted to a walking-beam attached to the piston-rods.

In this machine the agitator consists of a simple perforated iron plate attached at right angles to the piston-rod.

With this larger machine a workman can easily treat from 5 to 7 hectares per day. Price of machine, simple, 38 francs; double, 55 francs.

(*d*) *Albrand spraying-machine.*—This sprayer, known equally well under the name of the "Renovator," is one of the best machines working by compressed air. It is composed of a cylindrical reservoir (Fig. 20) containing 12 liters. This reservoir is of polished red copper. The aperture for filling, F, is closed by a screw-cap with a rubber joint. Upon the left side of the reservoir is attached an air-pump, B. The piston is jointed with the horizontal beam H by the rod G. The bar J, ending in the handle K, is worked by the operator. The pump communicates with the reservoir by a tube, opening into a valved box, E, to which is joined the tube D, reaching to the bottom of the reservoir, where it is perforated by a few small holes. A delivery-tube with a stop-cock carries the liquid from the bottom of the reservoir to the nozzle. The receiver being full of liquid the air in the reservoir is compressed by several strokes of the piston. The air rising through the liquid stirs it up and preserves its homogeneity, and when the stop-cock is turned the liquid is forced into the lance and through the nozzle.

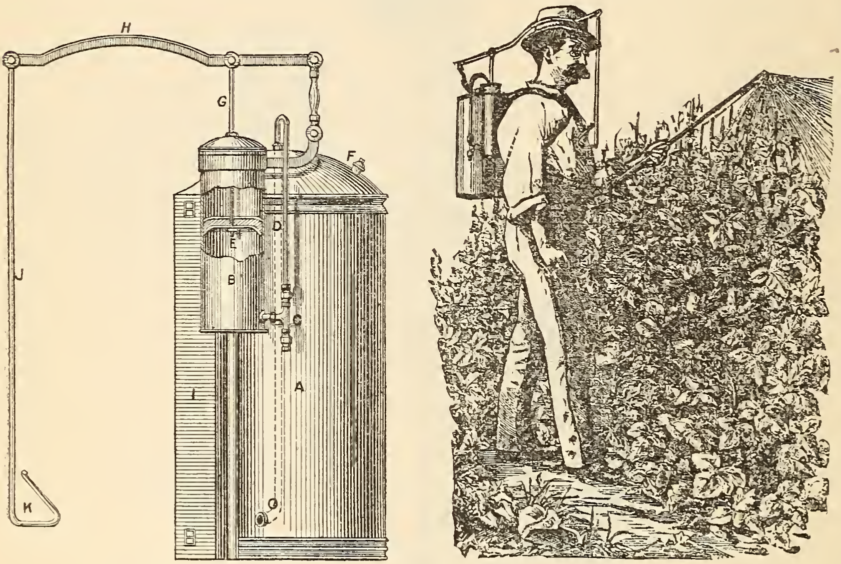


FIG. 20.

Fig. 21 is a Raveneau nozzle with a degorger. It consists of a tube 1 centimeter in diameter terminated by an orifice having a diameter of from 1 to 2 millimeters. A deflector is placed in front. The orifice is in two parts; the lower is fixed and the upper one movable. While at work the two parts are in juxtaposition and the liquid can only pass through the orifice 2 millimeters in diameter. When there is an obstruction the upper movable part is raised, the orifice is enlarged, and the liquid escapes easily, taking along all obstructions with it.

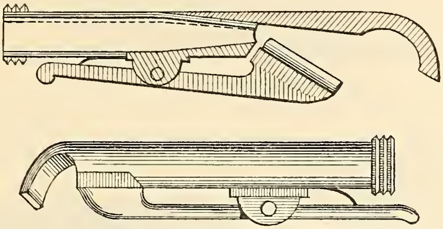


Fig. 21.

Price of machine, 60 francs. Two to three hectares of vines can be treated in a day.

(*e*) *Gaillot spraying-machine.*—The Gaillot machine, represented in section by Fig. 22, is very similar to the preceding. It also has a red copper reservoir, A, elliptical in section, with an air-pump, I, worked from beneath by a lever, M. The liquid passes through the tube R

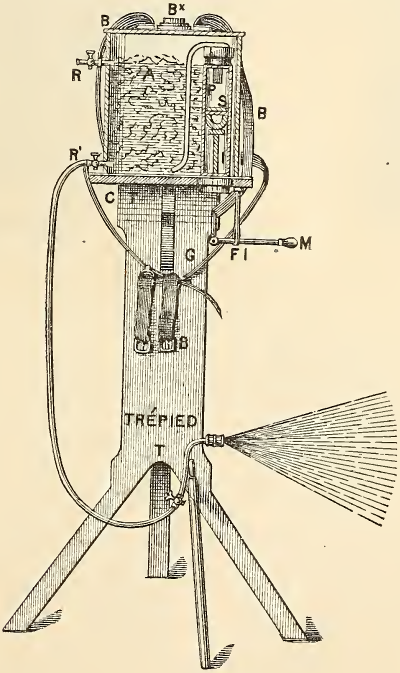


Fig. 22.

into a nozzle, which may be either a Raveneau or Riley. The nozzle end of the tube is attached to the end of a wooden rod 45 centimeters long, the end of which the operator holds in his hand, enabling him to reach all the green parts of the vine.

The figure shows the apparatus mounted upon a tripod, T. This support, intended to facilitate filling in the vineyard, is a happy invention, as it permits one man to operate it easily. One can easily treat a hectare per day. Price, complete apparatus, 65 francs.

(*f*) *Noël spraying-machine.*—The reservoir of this machine, Fig. 23, is a copper cylinder with an opening for filling closed by a screw cap. The air-pump, placed on the very bottom of the reservoir, is worked by a horizontal lever below and at the left. This pump consists of an elastic rubber plate fastened to the concave base of the receptacle. By alternately raising and lowering this the air is drawn in and the liquid forced out at the same time. The air above the rubber plate is compressed and enters the reservoir by a curved tube which opens at the bottom. The air rises to the top by bubbling through the liquid, and in this way preserves the homogeneity of the mixture.

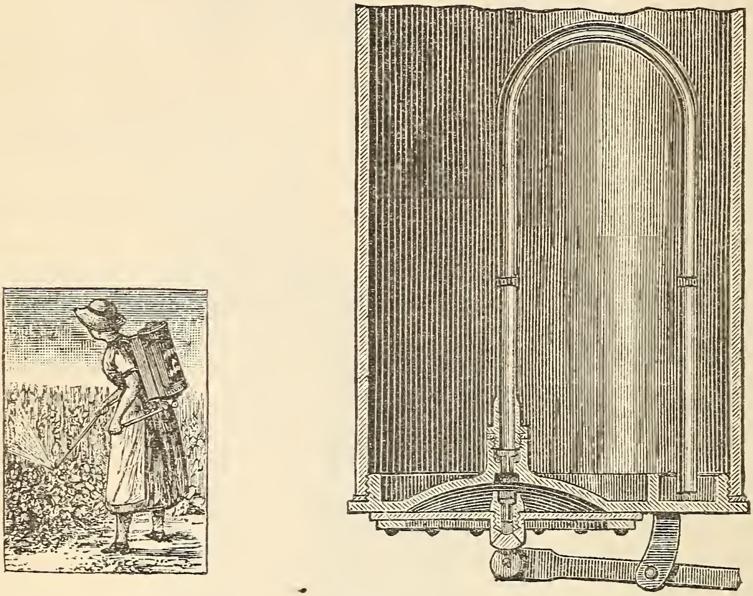


FIG. 23.

A rubber tube connects the reservoir with a lance carrying a nozzle.

This is a Riley with a perfected degorger (Fig. 24). The cap is pierced by a large hole, into a groove of which is loosely fitted a second cap perforated in the center by a very small orifice. This second cap gives a jet of several millimeters in a vertical direction. When the liquid is forced into the nozzle it raises the movable cap and passes out through the smaller orifice in small drops.

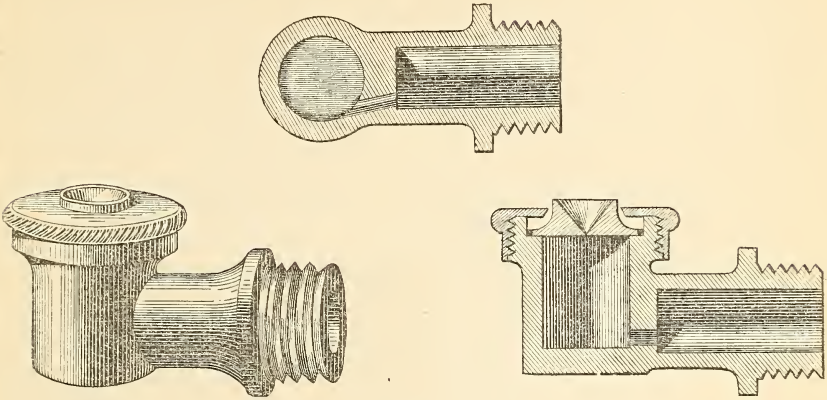


Fig. 24.

If it becomes clogged the operator presses down the movable cap with his finger, and the liquid escapes around its circumference carrying away any obstruction in the chamber.

The Noël machine is good, although the working of the pump is slow on account of the small volume of air introduced into the reservoir at at each stroke. It will treat about two thirds of a hectare per day. Its price is 60 francs.

GENERAL OBSERVATIONS.

All the instruments here described should be carefully emptied and cleaned after using.

The bellows should be kept in a dry place and the leather greased with a little tallow.

The machines for liquids should be washed and the leather packing of the pistons oiled or rubbed with tallow.

Before beginning work a feather, dipped in oil, should be passed over all the parts that are used for rapid movement and also over those subject to friction. This operation should be repeated three or four times per day in course of the treatment.

The treatment should not be performed too rapidly; a rate of three kilometers* (walking) per hour is a good average.

The operator ought to walk in the direction of the wind in order to avoid having the drops of liquid blown into his face. It is a good plan to cover his coat and pantaloons with blouse and overalls in order to protect his clothing from being spattered by the liquid, a circumstance that is inevitable even with the best machines.

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*One kilometer = $\frac{5}{8}$ of a mile ; 3 kilometers = $1\frac{7}{8}$ miles.

SUPPLEMENTARY NOTE ON EAU CELESTE.

It appears that the liquid remedies, eau celeste and the Bordeaux mixture, have given results always superior to those obtained from the use of powders. The efficacy of both these remedies in the treatment of the downy mildew, when properly applied, appears to be nearly equal. Treatments made with eau celeste while the shoots and leaves are yet young and tender have sometimes resulted in injury to these parts. It is stated * that all danger of injury to the foliage from the first application, made in early vegetation, may be entirely overcome by preparing the eau celeste for the first treatment in the following manner: Dissolve one pound of sulphate of copper in a gallon of hot water; to this solution add the liquid ammonia, a little at a time, until all the copper is precipitated; the liquid is then turbid and blue in color. Add two or three gallons of water and let stand to settle. Pour off the clear liquid, which contains sulphate of ammonia—the compound which causes the burning of the leaves. Then pour upon the precipitate left in the vessel just enough liquid ammonia to dissolve it. The result is a clear liquid of a beautiful deep blue color. When required for use, dilute to 22 gallons.

For treatments after the vines are in full foliage, the eau celeste may be prepared in the ordinary manner and applied without fear of injuring the vines.

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* "Progrès Agricole et Viticole," April 29, 1888.

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